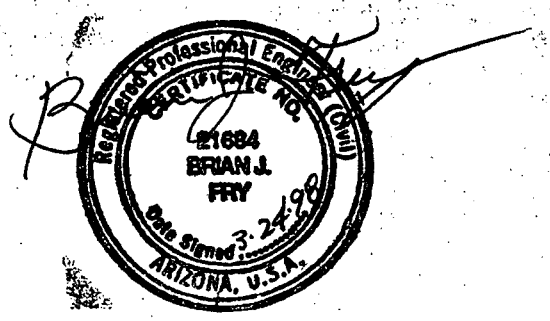
DRAINAGE CONCEPT REPORT
115TH AVENUE - GILA RIVER BRIDGE TO MC 85
(WO #80518)

Prepared for:

MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION



Prepared by:

DIBBLE & ASSOCIATES
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Since 1962

Subconsultant to:
Parsons Brinckerhoff

March 24, 1998

DRAINAGE CONCEPT REPORT
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DRAINAGE CONCEPT REPORT
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I. INTRODUCTION

A. General

This Drainage Concept Report is prepared for the Maricopa County Department of Transportation as part of the Improvement Study for 115th Avenue from the Gila River Bridge north to MC 85 (Buckeye Road). The project consists of analysis of the runoff generated within the road right-of-way area and off-site runoff reaching the roadway. Alternative drainage concepts are presented along with estimated construction costs. The project location is shown on **Figure 1**.

B. Study Area

The study area is characterized predominantly by agricultural land use. Residential development is beginning to replace agriculture in some locations and is expected to continue to replace the agricultural environment. The area is situated between the Agua Fria and Gila Rivers near their confluence. During high flows in the Gila River a portion of the area is subject to overbank flooding. The area is within the Salt River Valley Water Users Association (SRVWUA), Salt River Project (SRP) irrigation service area and is near the downstream end of the system. There is a large tailwater canal that traverses the area, flowing generally from east to west, referred to as the Buckeye Feeder Canal. The Buckeye Feeder Canal is aligned along a low-lying area that receives storm water runoff from the north and the south. The Canal flows adjacent to the east side of 115th Avenue for one mile before continuing west to the River. During storm events, runoff reaching the Buckeye Feeder Canal overtops the banks and flows overland toward 115th Avenue. Prior to reaching 115th Avenue the flow breaks out to the south resulting in flooding of several residences in its path. The runoff ponds along the east side of 115th Avenue before continuing west. The primary focus of the off-site drainage analysis is to identify solutions to the flooding problems along the Buckeye Feeder Canal from 107th Avenue to Dysart Road and more specifically in the vicinity of 115th Avenue. The study area identified for the Buckeye Feeder Canal analysis extends from 107th Avenue to Dysart Road and from Southern Avenue to Lower Buckeye Road. The study area is also shown on **Figure 1**.

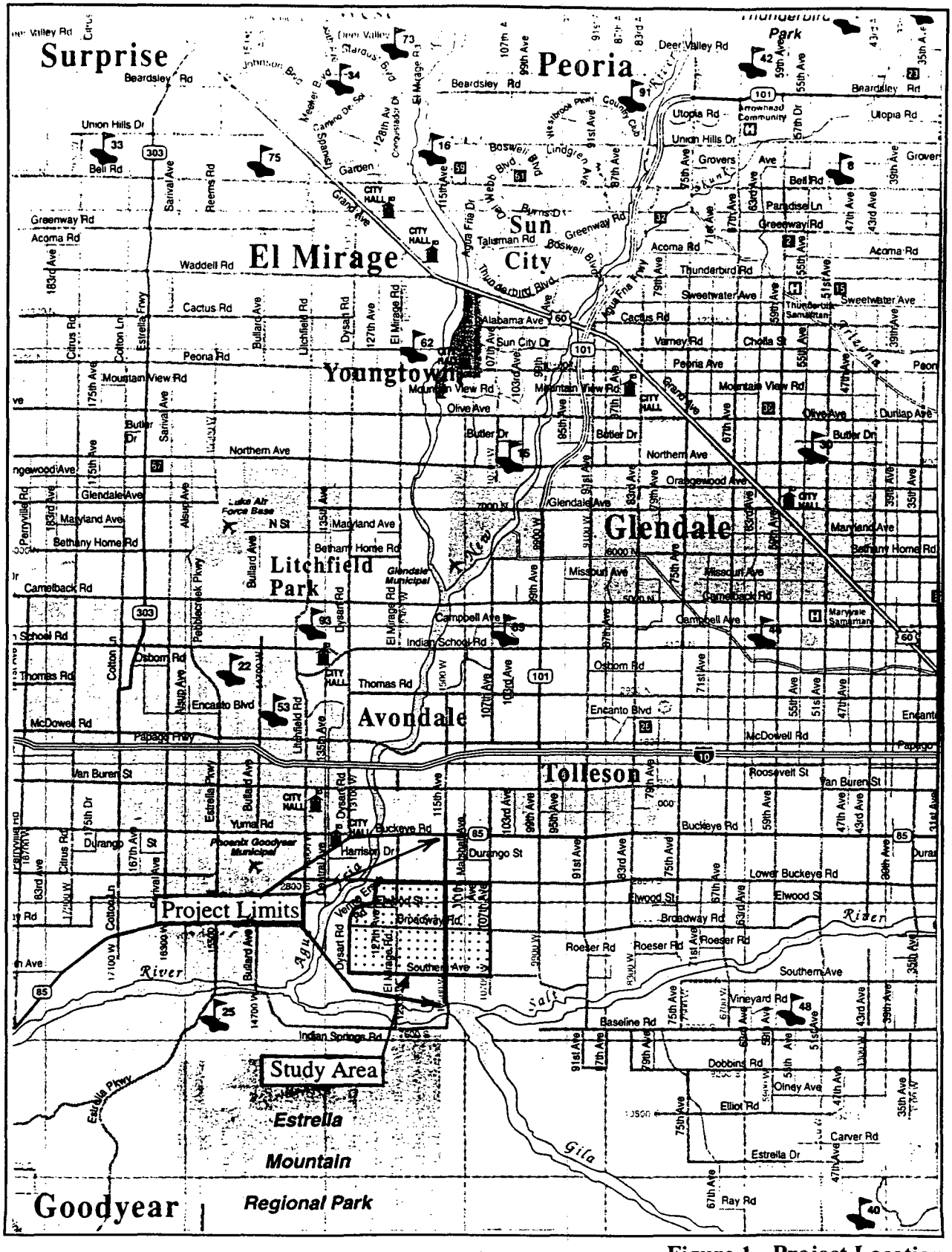


Figure 1 - Project Location

II. DESIGN CRITERIA

Drainage criterion for use in Maricopa County are presented in *Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics*, prepared by the Flood Control District of Maricopa County. Roadway design guidelines are presented in *Roadway Design Manual* prepared by Maricopa County Department of Transportation. The following specific criteria are used in this analysis.

A. On-site Drainage Criteria

The planned roadway section is a rural section with no curb and gutter. Pavement drainage will therefore be collected in roadside swales on each side of the road and conveyed to a suitable outfall. The following criteria apply to roadside ditches:

- Roadside ditches are to be sized to prevent the 10-year storm runoff from saturating the pavement subgrade.
- Sideslopes are to be no steeper than 4 to 1 (H:V) within the roadway clear zone.
- Trapezoidal channel bottoms will be a minimum of 4 feet wide for maintenance purposes. V-shaped channels are allowed in lieu of a 4-foot trapezoidal channel.

B. Off-site Drainage Criteria

Off-site drainage criteria will apply to roadway culverts and channel improvements to the Buckeye Feeder Canal. The following criteria apply:

- Cross road culverts for collector and arterial streets are to be designed to convey at least the 50-year peak discharge with no flow crossing over the roadway. Additionally,
- The flow depth over the roadway will be limited to 0.5 feet for the 100-year peak discharge.
- Open channels will be provided with freeboard equal to .25 times the sum of flow depth and velocity head for the design flow, with a minimum of 1 foot for subcritical flow and 2 feet for supercritical flow channels.
- The Froude number for all channel types is limited to a maximum of 0.86. For concrete, shotcrete, and mortar lined channels, the additional range of $1.13 \leq Fr \leq 2.0$ is allowed.

III. METHODOLOGY

A. Hydrology

Hydrology for the study area is presented in *Floodplain Delineation of the Tolleson Area, Hydrology Report*, October 1996, prepared by Dibble & Associates for the Flood Control District of Maricopa County. The hydrology report is in draft form, but constitutes the best available information regarding the runoff characteristics within the study area.

The hydrology from the Tolleson Area study was prepared using procedures and criteria from *Drainage Design Manual For Maricopa County, Arizona, Volume I, Hydrology* and the Flood Control District of Maricopa County *Drainage Design Menu System* (DDMS) computer software. Modifications were made to the 100-year Tolleson model to more accurately reflect the aerial reduction in rainfall within the project area and to model the detention basins for the detention alternative. The 10-year flows are taken from a revised model provided by the FCDMC. The drainage subarea map from the Tolleson study is enclosed as **Figure 2**.

Hydrology for the on-site drainage is prepared using the rational method as presented in the Drainage Design Manual.

B. Hydraulics

Culverts and channels are initially sized using *HDS-5, Hydraulic Design of Highway Culverts*, for culverts, and manning's equation for channels using an n-value of 0.013 for concrete. Certain portions of the Buckeye Feeder Canal were subsequently modeled with StormPlus to evaluate the backwater effects of the closely spaced culverts along 115th Avenue and the transition effects at the culvert inlets and outlets. StormPlus is a hydraulic analysis system developed by the Los Angeles County Flood Control District.

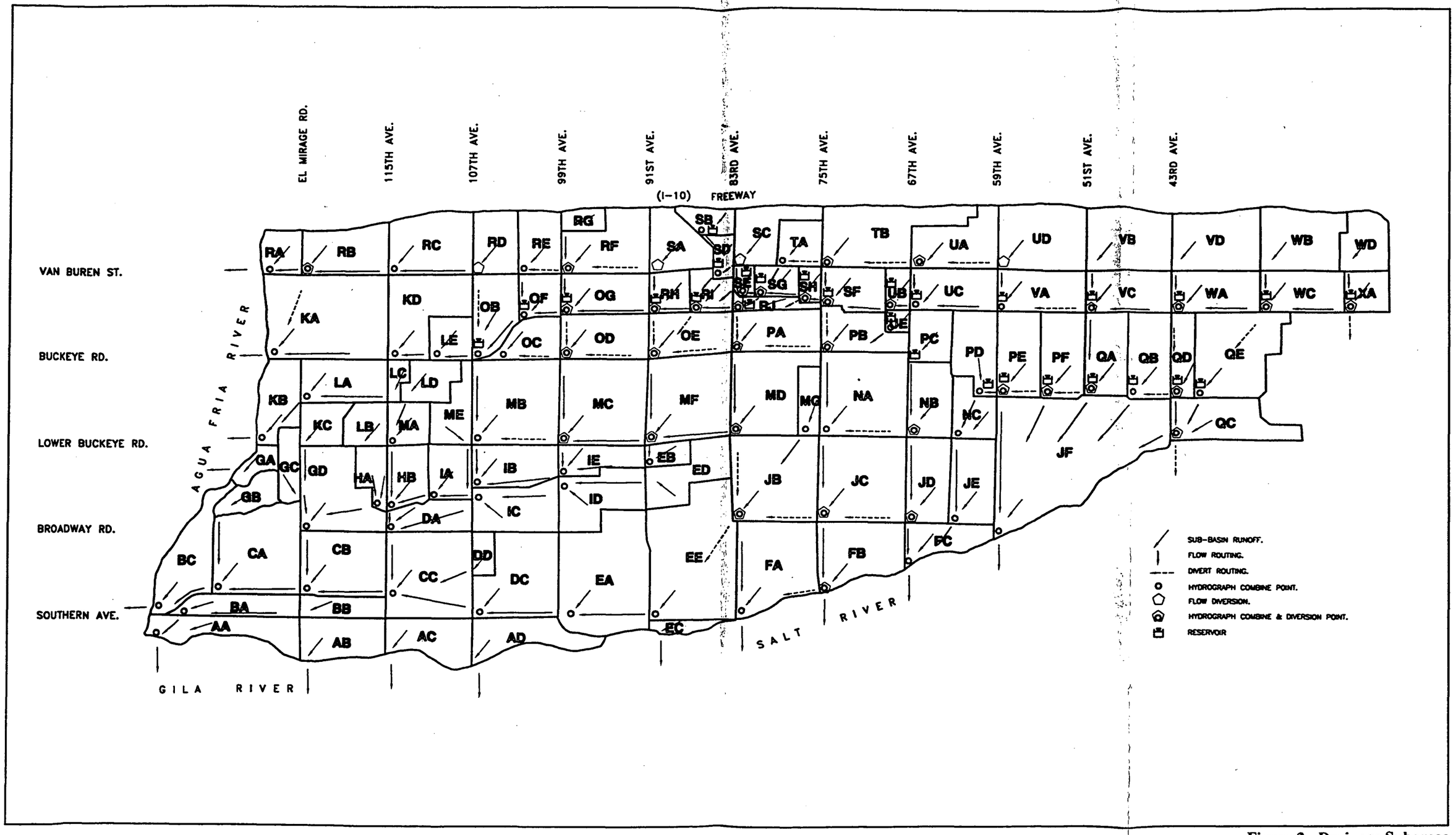


Figure 2 - Drainage Subareas

C. Alternatives Analysis

Alternatives are developed to solve flooding problems associated with the Buckeye Feeder Canal. The Scope of Work identifies three alternatives to be considered:

- Diverting accumulated excess flows southerly along the 115th Avenue alignment to the Gila River.
- Increase conveyance of all roadway under crossings to accommodate all potential canal flows. This alternative is to include all crossings within the study area including the boundary roadways and extending to the canal drain located west of Dysart Road.
- Combination of drainage measures and techniques such as diverting flows, augmentation of culvert conveyance capacities, and use of retention or detention basins.

Alternatives for the on-site drainage analysis are developed in conjunction with the No build Alternative, the Medium Cost Alternative, and the Full Cost Alternative presented in the *Improvement Study Report*, which is a companion document prepared as part of this study.

IV. RESULTS & RECOMMENDATIONS

A. On-site Drainage

On-site drainage includes pavement drainage and the runoff falling within the right-of-way on the shoulder or earthen area. Pavement drainage will be directed to side ditches running parallel to the roadway on both sides.

Currently, no culverts convey runoff under 115th Avenue except at the Buckeye Feeder Canal near Atlanta Avenue.

On the east side of 115th Avenue from Buckeye Road to the Buckeye Feeder Canal, the runoff flows south in the roadside ditch. The runoff is conveyed under side roads in culverts. The roadside ditch outlets into the canal. Runoff from Durango Street also flows in the roadside channel. From Southern to Atlanta, the runoff flows north, also to the canal. From Southern to the Gila River, the flow is south in a roadside ditch.

On the west side of 115th Avenue from Buckeye Road to Lower Buckeye Road, the right-of-way drainage flows south in a roadside ditch and then turns west along the north side of Lower Buckeye Road. The drainage along the west side of 115th Avenue from Lower Buckeye Road to Roeser also flows south. The runoff is diverted to the west at the following locations: Elwood, 1/4 mile north of Broadway, at Broadway, and at Roeser. From Roeser to the Buckeye Feeder Canal, the right-of-way drainage flows south into the canal. The right-of-way drainage from Southern to the Buckeye Feeder Canal flows north into the canal. Finally, from Southern to the Gila River, the right-of-way runoff flows south to the river.

The intent of the right-of-way drainage scheme for future improvements is to continue these existing drainage patterns. Runoff originating on the east side of 115th Avenue will be conveyed to the Buckeye Feeder Canal or the Gila River. Runoff on the west side will be diverted at the locations defined above.

Figure 3 shows the on-site drainage flow paths and computed peak discharges for existing conditions and for the Medium and Full Cost alternatives. The rational method computation sheets are contained in the **Appendix**.

The following table presents the side road culverts. The sizes are based on the roadside drainage 10-year discharges. Roadside swales will be v-shaped and designed to convey the 10-year discharge without inundating the pavement subgrade.

Location	Size
Durango Street (West Side)	610 mm (24-inch)
Durango Street (East Side)	610 mm (24-inch)
Lower Buckeye Road (East Side)	610 mm (24-inch)
Elwood Street (East Side)	760 mm (30-inch)

The addition of pavement as part of the Medium and Full Cost alternatives will increase the 10-year runoff as shown on **Figure 3**. During higher return period storms such as the 25-, 50- or 100-year storms, the increase in runoff caused by the additional pavement is negligible or zero.

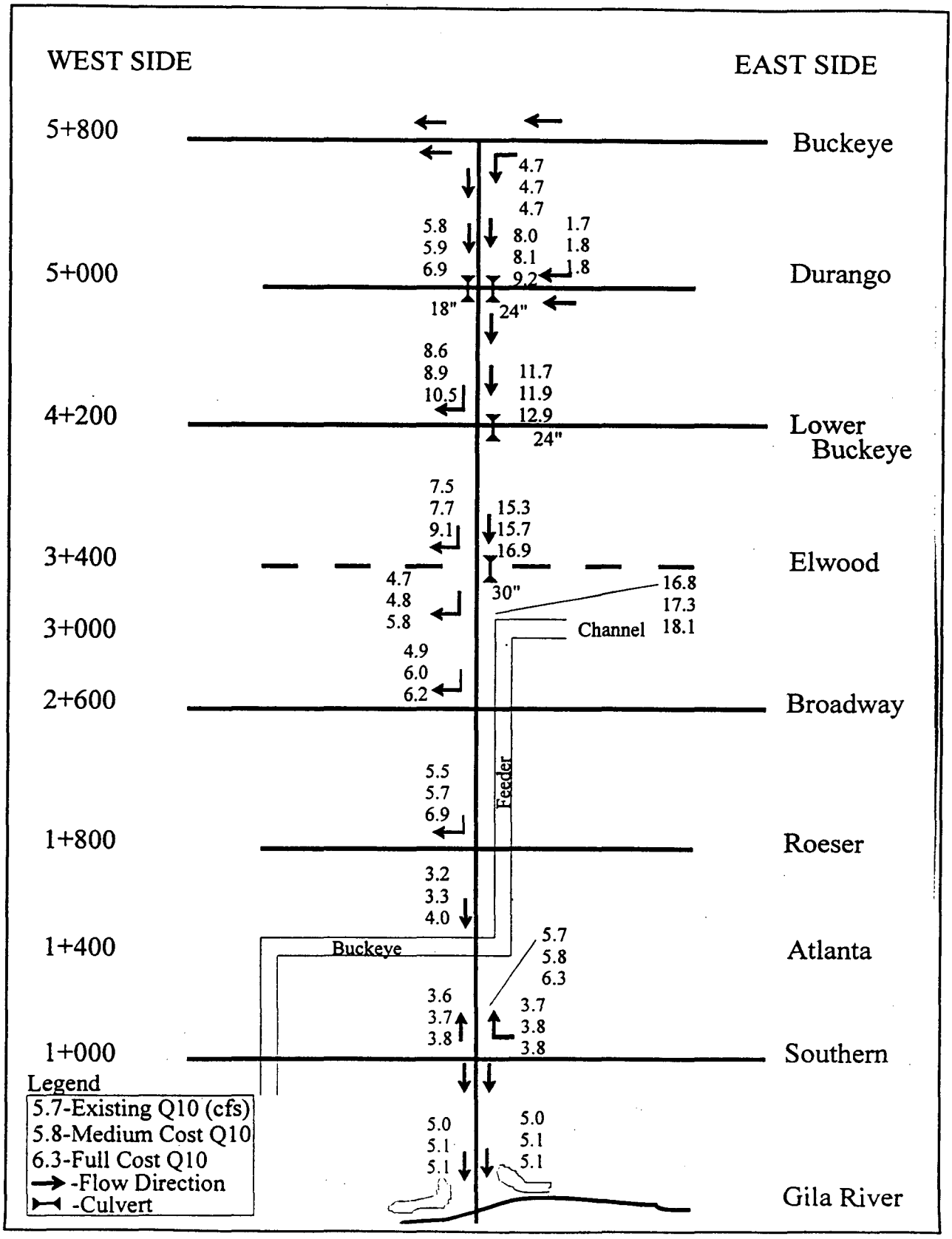


Figure 3 - On-site Drainage Flow Paths

B. Alternatives Analysis

Based on review of the project hydrology, available detailed mapping, and field reconnaissance, the following alternatives were developed to relieve flooding problems along the Buckeye Feeder Canal. The alternatives are shown on **Figures 4, 5, & 6**. Culvert and channel hydraulic calculation sheets are contained in the **Appendix**.

1. Existing Conditions

From approximately 91st Avenue westerly to 115th Avenue, the Buckeye Feeder Canal flows along a low point in the terrain. The Canal is a drain utilized to collect irrigation tailwater from adjacent fields. The Canal flows adjacent to the east side of 115th Avenue for one mile before continuing west to the River. During a storm event, runoff reaches the canal from the north and the south. If runoff exceeds the capacity of the canal, it flows overland parallel to the canal to a point east of 115th Avenue. Within this area it is difficult to determine with much certainty how much flow is conveyed on either side of the canal. Prior to reaching 115th Avenue the flow breaks out to the south resulting in flooding of several residences in its path. The runoff ponds along the east side of 115th Avenue before continuing west. The channel has a relatively large cross-section. However, the capacity is limited by small culverts at road and driveway crossings. SRP is contracted to deliver a constant discharge of 40 cfs to the Buckeye Irrigation District through the Buckeye Feeder Canal. The existing conditions 10-year and 100-year peak discharges from the HEC-1 model are presented in **Table 1** along with the reduced 100-year peak discharges resulting from the detention improvement alternative described below.

Table 1 - Peak Discharge Summary

Location Buckeye Feeder Canal (BFC)	HEC-1 ID	Ex. Cond. 100-yr Q	100-yr Q W/Detention	Ex. Cond. 10-yr Q
BFC East @ 115th Ave	CPHB	1944 cfs	756 cfs	1088 cfs
BFC @ Broadway Rd	CPDA	2325 cfs	962 cfs	1240 cfs
BFC West @ 115th Ave	CPCC	3068 cfs	1684 cfs	1593 cfs
BFC @ El Mirage Rd	CPCB	3205 cfs	*783 cfs	1667 cfs
BFC @ Dysart Rd	CPCA	3084 cfs	*893 cfs	1585 cfs

* - Flow is from local runoff generated downstream from 115th Avenue.

A significant amount of runoff from the east and south reaches the Buckeye Canal at the point where it turns west at 115th Avenue. The SRP Voiter Ditch flows into the Buckeye Canal in this vicinity. The Voiter Ditch has a very low capacity and is expected to have little impact on the surface runoff during large storms.

The FEMA floodplain for the Gila River is shown on **Exhibits 4-6**. The floodplain extends as far north as Broadway Road within the study limits. As a result, the alternative drainage improvements presented in this report will be inundated during a 100 year flow event in the Gila River and will not function as designed. The hydraulic analysis and alternative development presented in this report is based on the assumption that the 10 and 100 year design storm events are centered over the watershed shown on **Figure 2** and that the Gila River is not contributing to flooding in the area.

2. Alternative 1 - Detention

The detention alternative was originally intended to reduce 100-year peak discharges to a rate that could be conveyed in the existing Buckeye Feeder Canal with minimal improvements to the channel and replacement of the culverts. However, the 100-year peak discharges are so high compared to the Buckeye Canal cross-section capacity, that detention basins would be too large to reduce the flows enough to achieve that objective. Alternatively, detention basin sites are identified at points along the canal where runoff concentrates and the flow can be reasonably captured. The basins are made as large as practical for the available site and the attenuation achieved. The Alternative 1 improvements are shown on **Figure 4**.

Detention basins are located at 99th Avenue, 107th Avenue, and 115th Avenue. The 99th Avenue basin collects runoff flowing along the north side of the canal and local area sheet runoff in a flow-through basin concept. The flows in the Buckeye Feeder Canal are not intercepted by the basin. The stored runoff is discharged into the Buckeye Canal west of 99th Avenue through 2- 42 inch pipes. The canal is upsized from 99th Avenue to 107th Avenue to contain the discharge flow. The 107th Avenue basin collects runoff that crosses Lower Buckeye Road and overland flow from the east. Runoff crossing Lower Buckeye Road is conveyed to the basin in a new channel to prevent the runoff from overtopping 107th Avenue and continuing to the west. The channel flows by the basin with flows

in excess of 250 cfs flowing into the basin. The 250 cfs flow-by allows more basin volume for peak flow attenuation, making the basin more effective. The flow-by and the canal flow from the 99th Avenue basin are combined and conveyed under 107th Avenue. The canal is upsized from 107th Avenue to 115th Avenue to convey the combined flow. The 115th Avenue basin is situated on the south side of the Buckeye canal and collects runoff that flows over the canal and runoff flowing along the south side of the canal before it turns south. The Buckeye Canal acts as a flow-by channel on the north side of the basin allowing flows up to 300 cfs to flow by the basin. The basin discharges through 2-48 inch pipes into the canal. The combined flows are then conveyed along 115th Avenue to the point where the Buckeye Canal turns west. A channel is included, extending east from the Buckeye Canal at this point to collect the surface runoff not conveyed in the Voiter Ditch. The lateral channel joins the Buckeye Canal upstream of the 115th Avenue crossing and is sized for the 100 year flow. All channel improvements are sized for a concrete channel lining.

From this point, alternative alignments were considered to convey the runoff to the river. The existing Buckeye Canal alignment to the west would require channel improvements for approximately 3 miles, whereas the river is less than three quarters of a mile to the south. The 115th Avenue alignment has development along both sides of the road and there's a highpoint between the river and the canal that would need to be cut through. An alignment was selected a quarter mile west of 115th Avenue (117th Avenue alignment) that is unimproved and has a better grade to the river and is still less than a mile in length.

The 117th Avenue channel will penetrate the Holly Acres levee at the Gila River. The top of levee is 4 to 5 feet higher than the adjacent ground behind the levee. To prevent flows in the Gila River from moving up the channel and around the levee, berms will need to be extended along both sides of the 117th Avenue channel to an elevation of 943. The natural ground elevation between the Buckeye Feeder Canal and the Gila River varies but is around 940. Therefore the berms would need to extend all the way to the Buckeye Feeder Canal and would still not fully contain the flow. The water level that would escape the berms is expected to be above the design water surface in the river within the freeboard zone. The following alternatives could be pursued in response to the problem:

- The reduced freeboard could be accepted.

- The diversion structure at the Buckeye Feeder Canal & 117th Avenue could be designed to allow the excess flow to discharge to the west in the Buckeye Feeder Canal.
- A control gate could be installed at the Holly Acres levee that would be closed during flood events in the Gila River, preventing water from entering the 117th Avenue Channel. The gate could be manually or automatically activated.

The ability to meet the 40 cfs delivery requirement for the Buckeye Feeder Canal will be unaffected by the proposed improvements. The channel diversion at the 117th Avenue alignment will need to be designed to allow the first 40 cfs to continue west and all flows in excess of the 40 cfs to be directed south in the new channel to the Gila River.

Although the criteria for cross-road culverts only requires that they convey the 50 year discharge without overtopping, new culvert crossings are sized for the entire 100-year flow. This is done because the channels are sized for the 100-year flow with freeboard. The culverts are sized to be consistent with the channel design frequency.

100-year runoff generated downstream from 115th Avenue still exceeds the capacity of the crossings at El Mirage and Dysart Roads. The crossings are upsized as part of this alternative to convey the 100-year discharge. The Buckeye Feeder Canal is also improved by smoothing and lining the banks with concrete to make a hydraulically more efficient cross-section.

New right of way requirements for each channel reach are identified in the table on **Figure 4**. Existing right of way is used as much as possible. The right-of-way requirements for channels are based on two 12 foot access roads, one on each side. Where channels are next to public roads an access road is provided on one side only.

The attenuated flows resulting from the detention basins are summarized in **Table 1**. The flows are less than half the existing conditions flow and flood protection is provided from 99th Avenue along the channel alignment to the River. To ensure that the detention basins can be drained, the basin excavation depths are limited by the flow-line elevations of the existing downstream canals. If the

downstream canals are lowered with the channel improvements, the basins can be made deeper. Deeper basins will allow more peak flow attenuation by increasing the total storage volume, or the same attenuation can be achieved by reducing the required land area for the basins. The improvements to the Buckeye Canal west of 117th Avenue will provide flood protection for runoff generated west of 115th Avenue.

3. Alternative 2 - 100-year Conveyance

Alternative 2 is based on providing no detention and increasing the channel and road crossing capacity to convey the full 100-year existing conditions flow. The channel improvements begin at 107th Avenue where the Buckeye Feeder Canal will be improved to convey the 100-year peak discharge. The new channel will be realigned at a point 2000 feet east of 115th Avenue to collect runoff at an existing low point preventing runoff from breaking away from the canal to the south. From 115th Avenue the channel follows the same alignment as Alternative 1 and includes the measures described with Alternative 1 required to penetrate the Holly Acres levee. The channel improvements are all concrete lined. The Alternative 2 improvements are shown on **Figure 5**. The same lateral channel is included in Alternative 2, extending east from the Buckeye Canal 115th Avenue crossing, to collect the surface runoff not conveyed in the Voiter Ditch. The improvements downstream from the 117th Avenue alignment are the same as for Alternative 1.

Alternative 2 channels and culverts are sized for the 100-year existing conditions flows in **Table 1**. Although the channels are larger than the Alternative 1 channels, there is much less right-of-way and excavation required due to elimination of the detention basins.

4. Alternative 3 - 10-year Conveyance

Alternative 3 is based on providing 10-year protection as a cost saving option to either reduce the project cost or allow phasing of improvements. Alternative 3 consists of channel improvements and concrete lining to the Buckeye Canal from 107th Avenue to Dysart Road along its existing alignment with channels and culverts sized for the 10-year storm, except that the channel is re-routed east of 115th Avenue through the low point described with Alternative 2. The 10-year flows are nearly the same as the attenuated flows from Alternative 1. The Alternative 3 channels and culverts could be

constructed as the first phase of a 100-year plan. The basins and remaining channel improvements would then be made at a later time. The Alternative 3 improvements are shown on **Figure 6**. The lateral channel at the 115th Avenue crossing is included in Alternative 3, sized for the 10-year flow. To provide a minimum 100-year level of protection for existing structures, floodproofing measures were included for overland flow occurring during a 100-year storm that is not contained in the channels. For homes north of the Voiter Ditch, individual berms are planned to be constructed around the homes to prevent flooding. For homes south of the Voiter Ditch a small levee is planned to divert surface runoff around the homes to the new lateral channel.

Alternatively, the 10-year flows could be directed to the Gila River along the 117th Avenue alignment as shown on Alternatives 1 and 2. However, the Holly Acres levee issues would then need to be addressed as described in Alternative 1.

C. Estimated Costs

The estimated costs for the three alternatives are summarized in **Table 2**. Alternative 1 is significantly more expensive than the other alternatives due to the right of way costs for the detention basins. Alternative 2 is the least costly alternative that provides 100-year protection in the study area. Alternative 3 provides a significant benefit, although not a 100-year flood protection benefit, to a significant area at a somewhat lower cost. A breakdown of the estimated costs is contained in the **Appendix**.

Table 2 - Cost Summary

Alternative	Cost
Alt. 1 - Detention	$8.7 Million
Alt. 2 - 100-yr Conveyance	$4.7 Million
Alt. 3 - 10-yr Conveyance	$4.0 Million

D. Joint Project Recommendations

The Flood Control District of Maricopa County (FCDMC) frequently participates in implementation of regional flood control projects based on an internal prioritization process applied to projects proposed by various entities within the County. Cost sharing is one of the criteria included in the prioritization. If the agency proposing the project is willing to cost share the project, typically at a level of 50 percent, the project is scored more highly than projects with no cost sharing. The

FCDMC is a good potential partner in the implementation of the Buckeye Feeder Canal improvements.

Salt River Project (SRP) is also a potential partner, based on their need to alleviate potential liability from flooding caused by overtopping of the Buckeye Feeder Canal. All the alternatives presented in this report utilize SRP right of way and facilities and will require cooperation from SRP.

DETENTION BASINS

No.	Total Q to Basin cfs	Flow-by cfs	Detention Basin: Area acres	Volume acre-ft	Qin cfs	Qout cfs	Outlet Pipe	Total Q at Outlet cfs
1	680	0	20	64	680	283	2-42"	283
2	1087	250	40	125	837	448	2-60"	949*
3	1393	300	37	237	1028	612	2-48"	912*

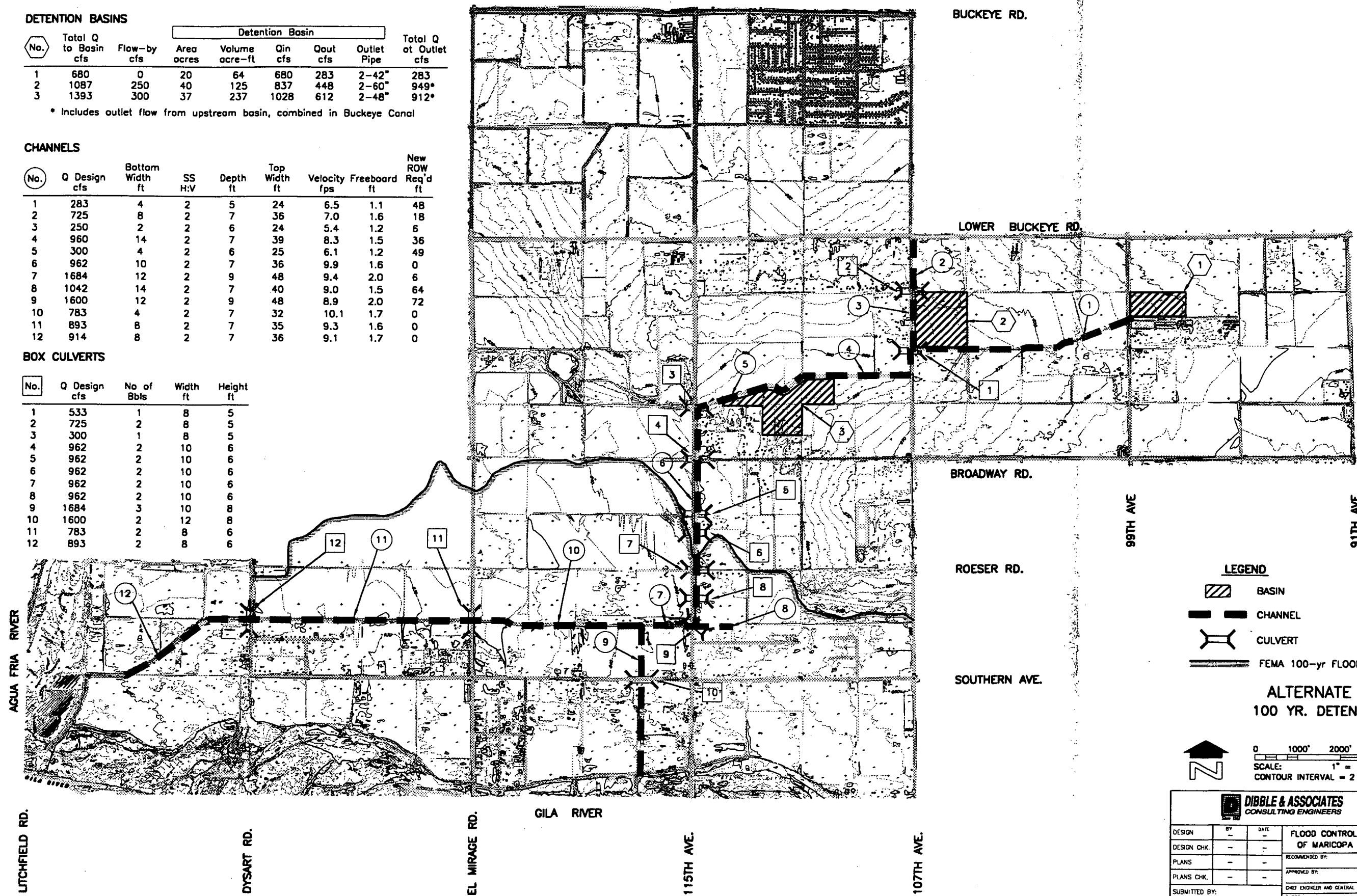
* Includes outlet flow from upstream basin, combined in Buckeye Canal

CHANNELS

No.	Q Design cfs	Bottom Width ft	SS H:V	Depth ft	Top Width ft	Velocity fps	Freeboard ft	New ROW Req'd ft
1	283	4	2	5	24	6.5	1.1	48
2	725	8	2	7	36	7.0	1.6	18
3	250	2	2	6	24	5.4	1.2	6
4	960	14	2	7	39	8.3	1.5	36
5	300	4	2	6	25	6.1	1.2	49
6	962	10	2	7	36	9.9	1.6	0
7	1684	12	2	9	48	9.4	2.0	6
8	1042	14	2	7	40	9.0	1.5	64
9	1600	12	2	9	48	8.9	2.0	72
10	783	4	2	7	32	10.1	1.7	0
11	893	8	2	7	35	9.3	1.6	0
12	914	8	2	7	36	9.1	1.7	0

BOX CULVERTS

No.	Q Design cfs	No of Bbls	Width ft	Height ft
1	533	1	8	5
2	725	2	8	5
3	300	1	8	5
4	962	2	10	6
5	962	2	10	6
6	962	2	10	6
7	962	2	10	6
8	962	2	10	6
9	1684	3	10	8
10	1600	2	12	8
11	783	2	8	6
12	893	2	8	6



LEGEND

- BASIN
- CHANNEL
- CULVERT
- FEMA 100-yr FLOOD LIMITS

ALTERNATE 1
100 YR. DETENTION

N

0 1000' 2000' 3000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 2 FEET

DIBBLE & ASSOCIATES
CONSULTING ENGINEERS

	BY	DATE
DESIGN	–	–
DESIGN CHK.	–	–
PLANS	–	–
PLANS CHK.	–	–

SUBMITTED BY: _____ DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE

APPROVED BY: _____ DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET _____ OF

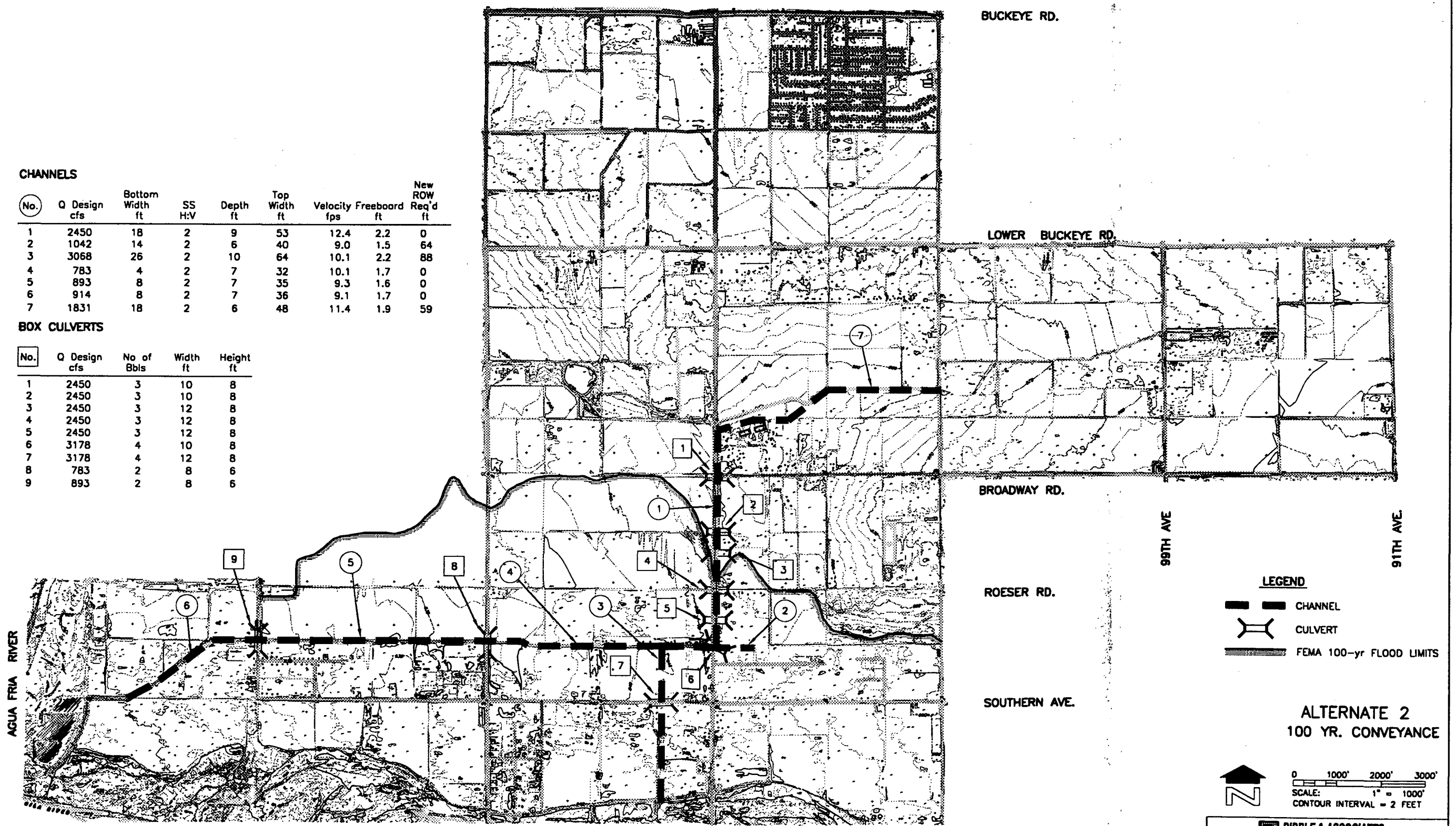
FIGURE 4

CHANNELS

No.	Q Design cfs	Bottom Width ft	SS H:V	Depth ft	Top Width ft	Velocity fps	Freeboard ft	New ROW Req'd ft
1	2450	18	2	9	53	12.4	2.2	0
2	1042	14	2	6	40	9.0	1.5	64
3	3068	26	2	10	64	10.1	2.2	88
4	783	4	2	7	32	10.1	1.7	0
5	893	8	2	7	35	9.3	1.6	0
6	914	8	2	7	36	9.1	1.7	0
7	1831	18	2	6	48	11.4	1.9	59

BOX CULVERTS

No.	Q Design cfs	No of Bbls	Width ft	Height ft
1	2450	3	10	8
2	2450	3	10	8
3	2450	3	12	8
4	2450	3	12	8
5	2450	3	12	8
6	3178	4	10	8
7	3178	4	12	8
8	783	2	8	6
9	893	2	8	6



ALTERNATE 2
100 YR. CONVEYANCE

N

0 1000' 2000' 3000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 2 FEET

DIBBLE & ASSOCIATES
CONSULTING ENGINEERS

	BY	DATE
DESIGN	-	-
DESIGN CHK.	-	-
PLANS	-	-
PLANS CHK.	-	-

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET OF

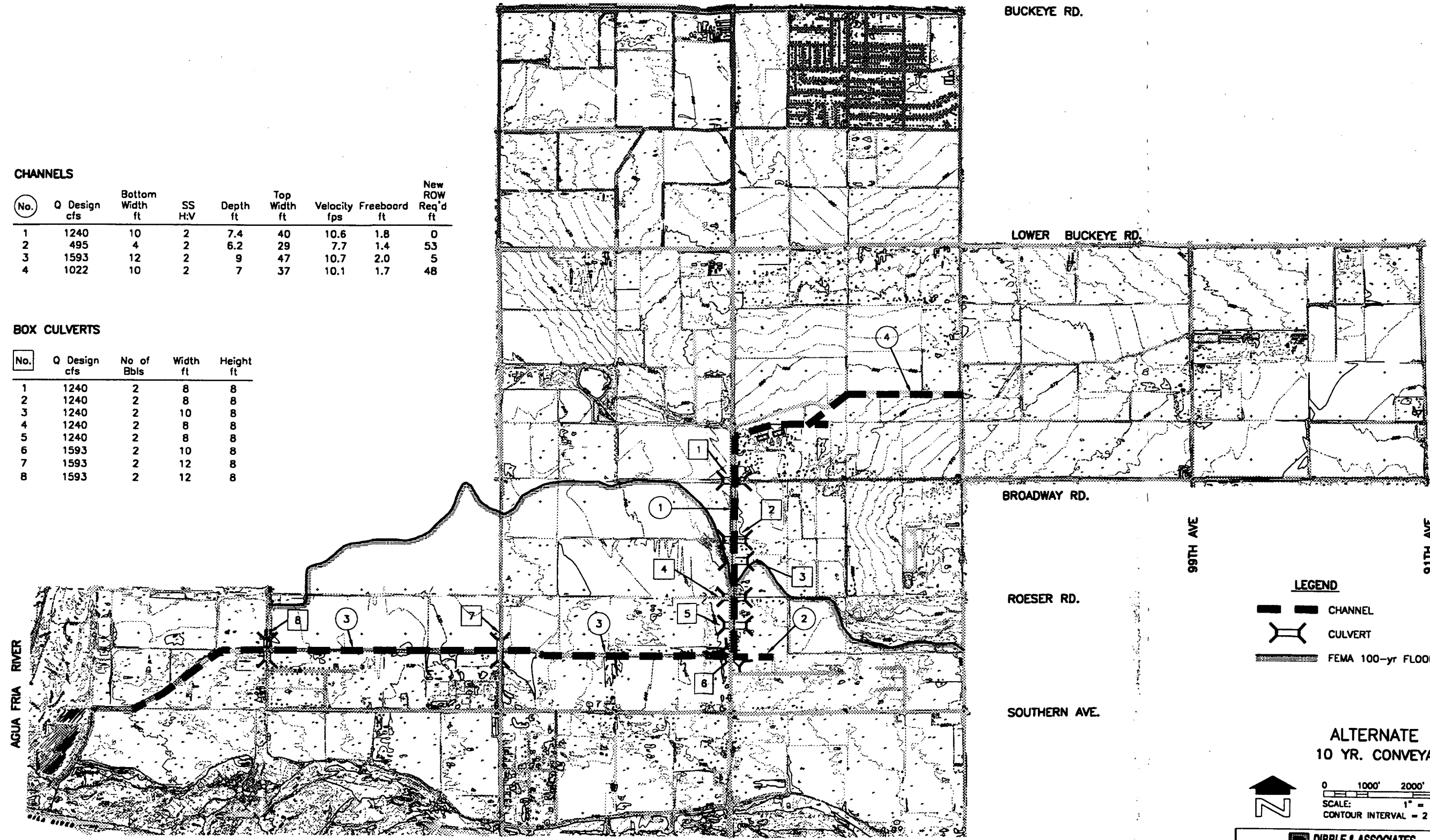
FIGURE 5

CHANNELS

No.	Q Design cfs	Bottom Width ft	SS H:V	Depth ft	Top Width ft	Velocity fps	Freeboard ft	New ROW Req'd ft
1	1240	10	2	7.4	40	10.6	1.8	0
2	495	4	2	6.2	29	7.7	1.4	53
3	1593	12	2	9	47	10.7	2.0	5
4	1022	10	2	7	37	10.1	1.7	48

BOX CULVERTS

No.	Q Design cfs	No of Bbls	Width ft	Height ft
1	1240	2	8	8
2	1240	2	8	8
3	1240	2	10	8
4	1240	2	8	8
5	1240	2	8	8
6	1593	2	10	8
7	1593	2	12	8
8	1593	2	12	8



ALTERNATE 3
10 YR. CONVEYANCE

N

0 1000' 2000' 3000'
SCALE: 1" = 1000'
CONTOUR INTERVAL = 2 FEET

DIBBLE & ASSOCIATES
CONSULTING ENGINEERS

	BY	DATE
DESIGN	–	–
DESIGN CHK.	–	–
PLANS	–	–
PLANS CHK.	–	–

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET OF

FIGURE 6

APPENDIX

- Rational Method Summary of Right-of-way Drainage
  - Existing Conditions
  - Medium Cost Alternative
  - Full Cost Alternative
- HEC-1 Summary Output
  - Existing Conditions, 100-year Storm
  - Alternative 1, 100-year Detention
  - Alternative 2, 100-year Conveyance
  - Alternative 3, 10-year Conveyance
- Culvert Design Calculations
- Channel Calculations
- Cost Summary

115th Avenue Drainage

Rational Method Summary of Right-of-Way Drainage
Existing Conditions

Area No.	Begin Station	End Station	Side	Flow Direction	Paved Area (s.f.)	Earthen Area (s.f.)	Coeff "C"	Section Length (ft)	Total Length (ft)	Section Slope (ft/mi)	Total Slope (ft/mi)	Kb	I (in/hr)	Tc (min)	Tc (hr)	Q10 (cfs)	Q10 (m3/sec)
1	Buckeye East		E	W	51200	36800	0.72	1600	1600	12.5	12.5	0.038091	3.20	20.22	0.34	4.7	0.132
2	Durango	Buckeye	E	S	113600	117400	0.70	2600	4200	10.4	11.45	0.035472	2.15	37.74	0.63	8.0	0.226
3	Durango East		E	W	17600	14400	0.71	800	800	5	5	0.040837	3.25	19.58	0.33	1.7	0.048
4	L Buckeye	Durango	E	S	193600	212400	0.70	2600	6800	10.2	10.9	0.033941	1.80	50.98	0.85	11.7	0.333
5	Elwood	L Buckeye	E	S	256960	294240	0.69	2640	9440	31	16.5	0.033111	1.75	52.70	0.88	15.3	0.433
6	1/4 mi N Bwy	Elwood	E	S	288640	335160	0.69	1320	10760	32	18.4	0.032775	1.70	54.71	0.91	16.8	0.476
7	Channel		SEE OFFSITE DRAINAGE CALCULATIONS														
8	Southern	Atlanta	E	N	65680	78920	0.69	1320	2320	8	8	0.036743	2.50	30.14	0.50	5.7	0.162
9	Southern		E	W	34000	38000	0.69	1000	1000	8.1	8.1	0.038636	3.25	18.32	0.31	3.7	0.105
10	Gila Bank	Southern	E	S	48000	62000	0.69	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.0	0.141
11	Durango	Buckeye	W	S	62400	80600	0.69	2640	2600	10.4	10.4	0.036773	2.55	29.21	0.49	5.8	0.164
12	L Buckeye	Durango	W	S	124800	161200	0.69	2640	5280	10.2	10.3	0.034892	1.90	45.43	0.76	8.6	0.244
13	Elwood	L Buckeye	W	S	63360	81840	0.69	2640	2640	31	31	0.036732	3.25	19.12	0.32	7.5	0.212
14	1/4 mi N Bwy	Elwood	W	S	31680	40920	0.69	1320	1320	32	32	0.038613	4.05	12.64	0.21	4.7	0.132
15	Broadway	1/4 mi N Bwy	W	S	31680	40920	0.69	1320	1320	40	40	0.038613	4.30	11.53	0.19	4.9	0.14
16	Roeser	Broadway	W	S	63360	81840	0.69	2640	2640	8	8	0.036732	2.40	32.65	0.54	5.5	0.156
17	Atlanta	Roeser	W	S	31680	40920	0.69	1320	1320	5	5	0.038613	2.75	26.03	0.43	3.2	0.09
18	Southern	Atlanta	W	N	31680	40920	0.69	1320	1320	8	8	0.038613	3.15	21.37	0.36	3.6	0.103
19	Gila Bank	Southern	W	S	48000	62000	0.69	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.0	0.141

C - Roadway (10-year) = 0.8
C - Shoulders & Right of way (10 year) 0.6
Kb = m Log A + b
m = -0.00625
b = 0.04
A = Area (ac)
Tc = 11.4 L^.5 Kb^0.52 S^-0.31 I^-0.38
Q = C i A (10 year Discharge)

115th Avenue Drainage

Rational Method Summary of Right-of-Way Drainage
Medium Cost Alternative

Area No.	Begin Station	End Station	Side	Flow Direction	Paved Area (s.f.)	Earthen Area (s.f.)	Coeff "C"	Section Length (ft)	Total Length (ft)	Section Slope (ft/mi)	Total Slope (ft/mi)	Kb	I (in/hr)	Tc (min)	Tc (hr)	Q10 (cfs)	Q10 (m3/sec)
1	Buckeye East		E	W	51200	36800	0.72	1600	1600	12.5	12.5	0.038091	3.20	20.22	0.34	4.7	0.132
2	Durango	Buckeye	E	S	129200	101800	0.71	2600	4200	10.4	11.45	0.035472	2.15	37.74	0.63	8.1	0.229
3	Durango East		E	W	24000	8000	0.75	800	800	5	5	0.040837	3.25	19.58	0.33	1.8	0.051
4	L Buckeye	Durango	E	S	231200	174800	0.71	2600	6800	10.2	10.9	0.033941	1.80	50.98	0.85	11.9	0.337
5	Elwood	L Buckeye	E	S	310400	240800	0.71	2640	9440	31	16.5	0.033111	1.75	52.70	0.88	15.7	0.445
6	1/4 mi N Bwy	Elwood	E	S	350000	273800	0.71	1320	10760	32	18.4	0.032775	1.70	54.71	0.91	17.3	0.489
7	Channel		SEE OFFSITE DRAINAGE CALCULATIONS														
8	Southern	Atlanta	E	N	73600	71000	0.70	1320	2320	8	8	0.036743	2.50	30.14	0.50	5.8	0.164
9	Southern		E	W	34000	38000	0.69	1000	1000	8.1	8.1	0.038636	3.30	18.21	0.30	3.8	0.107
10	Gila Bank	Southern	E	S	60000	50000	0.71	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.1	0.145
11	Durango	Buckeye	W	S	78000	65000	0.71	2640	2600	10.4	10.4	0.036773	2.55	29.21	0.49	5.9	0.168
12	L Buckeye	Durango	W	S	156000	130000	0.71	2640	5280	10.2	10.3	0.034892	1.90	45.43	0.76	8.9	0.251
13	Elwood	L Buckeye	W	S	79200	66000	0.71	2640	2640	31	31	0.036732	3.25	19.12	0.32	7.7	0.218
14	1/4 mi N Bwy	Elwood	W	S	39600	33000	0.71	1320	1320	32	32	0.038613	4.05	12.64	0.21	4.8	0.136
15	Broadway	1/4 mi N Bwy	W	S	48840	36960	0.71	1320	1320	40	40	0.03816	4.30	11.46	0.19	6.0	0.17
16	Roeser	Broadway	W	S	79200	66000	0.71	2640	2640	8	8	0.036732	2.40	32.65	0.54	5.7	0.161
17	Atlanta	Roeser	W	S	39600	33000	0.71	1320	1320	5	5	0.038613	2.75	26.03	0.43	3.3	0.092
18	Southern	Atlanta	W	N	39600	33000	0.71	1320	1320	8	8	0.038613	3.15	21.37	0.36	3.7	0.106
19	Gila Bank	Southern	W	S	60000	50000	0.71	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.1	0.145

C - Roadway (10-year) = 0.8
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Kb = m Log A + b
m = -0.00625
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A = Area (ac)
Tc = 11.4 L^.5 Kb^0.52 S^-0.31 I^-0.38
Q = C i A (10 year Discharge)

115th Avenue Drainage

Rational Method Summary of Right-of-Way Drainage
Full Cost Alternative

Area No.	Begin Station	End Station	Side	Flow Direction	Paved Area (s.f.)	Earthen Area (s.f.)	Coeff "C"	Section Length (ft)	Total Length (ft)	Section Slope (ft/mi)	Total Slope (ft/mi)	Kb	I (in/hr)	Tc (min)	Tc (hr)	Q10 (cfs)	Q10 (m3/sec)
1	Buckeye East		E	W	51200	36800	0.72	1600	1600	12.5	12.5	0.038091	3.20	20.22	0.34	4.7	0.132
2	Durango	Buckeye	E	S	149500	110100	0.72	2600	4200	10.4	11.45	0.035155	2.15	37.56	0.63	9.2	0.261
3	Durango East		E	W	24000	8000	0.75	800	800	5	5	0.040837	3.25	19.58	0.33	1.8	0.051
4	L Buckeye	Durango	E	S	267100	164900	0.72	2600	6800	10.2	10.9	0.033773	1.80	50.84	0.85	12.9	0.364
5	Elwood	L Buckeye	E	S	362140	215460	0.73	2640	9440	31	16.5	0.032984	1.75	52.60	0.88	16.9	0.48
6	1/4 mi N Bwy	Elwood	E	S	409660	227340	0.73	1320	10760	32	18.4	0.032718	1.70	54.66	0.91	18.1	0.514
7	Channel		SEE OFFSITE DRAINAGE CALCULATIONS														
8	Southern	Atlanta	E	N	81520	76280	0.70	1320	2320	8	8	0.036506	2.50	30.04	0.50	6.3	0.18
9	Southern		E	W	34000	38000	0.69	1000	1000	8.1	8.1	0.038636	3.30	18.21	0.30	3.8	0.107
10	Gila Bank	Southern	E	S	60000	50000	0.71	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.1	0.145
11	Durango	Buckeye	W	S	91300	74600	0.71	2640	2600	10.4	10.4	0.03637	2.55	29.04	0.48	6.9	0.195
12	L Buckeye	Durango	W	S	184900	152600	0.71	2640	5280	10.2	10.3	0.034443	1.90	45.13	0.75	10.5	0.296
13	Elwood	L Buckeye	W	S	95040	76560	0.71	2640	2640	31	31	0.036279	3.25	19.00	0.32	9.1	0.257
14	1/4 mi N Bwy	Elwood	W	S	55440	30360	0.73	1320	1320	32	32	0.03816	4.05	12.56	0.21	5.8	0.165
15	Broadway	1/4 mi N Bwy	W	S	55440	30360	0.73	1320	1320	40	40	0.03816	4.30	11.46	0.19	6.2	0.175
16	Roeser	Broadway	W	S	110880	60720	0.73	2640	2640	8	8	0.036279	2.40	32.44	0.54	6.9	0.195
17	Atlanta	Roeser	W	S	55440	30360	0.73	1320	1320	5	5	0.03816	2.75	25.87	0.43	4.0	0.112
18	Southern	Atlanta	W	N	47520	25080	0.73	1320	1320	8	8	0.038613	3.15	21.37	0.36	3.8	0.109
19	Gila Bank	Southern	W	S	60000	50000	0.71	2000	2000	11.7	11.7	0.037486	2.85	23.92	0.40	5.1	0.145

C - Roadway (10-year) = 0.8
C - Shoulders & Right of way (10 year) 0.6
Kb = m Log A + b
m = -0.00625
b = 0.04
A = Area (ac)
Tc = 11.4 L^.5 Kb^0.52 S^-0.31 I^-0.38
Q = C i A (10 year Discharge)

3 COMBINED AT							
+	CPOD3	470.	16.17	320.	114.	110.	13.14
DIVERSION TO							
+	DIOC	85.	16.17	58.	21.	20.	13.14
HYDROGRAPH AT							
+	CPOD4	385.	16.17	263.	93.	90.	13.14
ROUTED TO							
+	RTODMC	349.	17.42	253.	89.	86.	13.14
HYDROGRAPH AT							
+	SUBMC	643.	13.00	221.	57.	55.	1.00
3 COMBINED AT							
+	CPMC1	983.	14.17	603.	203.	196.	16.40
DIVERSION TO							
+	DIMB	375.	14.17	231.	78.	75.	16.40
HYDROGRAPH AT							
+	CPMC2	607.	14.17	372.	125.	120.	16.40
ROUTED TO							
+	RTMCIE	595.	14.50	369.	123.	119.	16.40
HYDROGRAPH AT							
+	SUBEB	137.	12.42	24.	6.	6.	.14
HYDROGRAPH AT							
+	CPEB1	451.	13.00	211.	58.	56.	2.75
2 COMBINED AT							
+	CPEB2	522.	12.83	234.	64.	62.	2.89
ROUTED TO							
+	RTEBIE	506.	13.17	232.	63.	61.	2.89
HYDROGRAPH AT							
+	SUBIE	201.	12.83	62.	16.	15.	.26
2 COMBINED AT							
+	CPIE1	680.	13.08	289.	79.	76.	3.15
2 COMBINED AT							
+	CPIE2	1015.	14.25	628.	198.	191.	16.80
ROUTED TO							
+	RTIEIB	986.	15.00	611.	190.	183.	16.80
HYDROGRAPH AT							
+	SUBOC	421.	12.25	67.	19.	18.	.31
HYDROGRAPH AT							
+	CPOC1	85.	16.17	58.	21.	20.	13.14
ROUTED TO							
+	RTDIOC	67.	18.58	53.	19.	18.	13.14
2 COMBINED AT							
+	CPOC2	421.	12.25	95.	39.	38.	.31
ROUTED TO							
+	RTOCMB	261.	13.33	88.	37.	35.	.31
HYDROGRAPH AT							
+	SUBMB	631.	12.92	210.	53.	51.	.99
HYDROGRAPH AT							
+	CPMB	375.	14.17	231.	78.	75.	16.40
ROUTED TO							
+	RTDIMB	352.	15.25	223.	74.	71.	16.40
3 COMBINED AT							
+	CPMB1	782.	13.25	439.	155.	150.	18.19
ROUTED TO							
+	RTMBIB	724.	13.83	433.	150.	145.	18.19
HYDROGRAPH AT							
+	SUBIB	326.	12.92	102.	26.	25.	.46
3 COMBINED AT							
+	CPIB	1715.	14.00	1076.	363.	350.	18.56
ROUTED TO							
+	RTIBIA	1715.	14.08	1076.	362.	349.	18.56
HYDROGRAPH AT							
+	SUBME	218.	12.67	45.	12.	11.	.32

+	ROUTED TO	RTMEIA	165.	13.50	45.	12.	11.	.32
+	HYDROGRAPH AT	SUBIA	281.	12.50	49.	13.	12.	.31
+	3 COMBINED AT	CPIA	1831.	14.00	1131.	384.	370.	19.19
+	ROUTED TO	RTIAHB	1827.	14.17	1130.	381.	367.	19.19
+	HYDROGRAPH AT	SUBLD	314.	12.25	48.	15.	14.	.28
+	ROUTED TO	RTLDMA	297.	12.50	48.	15.	14.	.28
+	HYDROGRAPH AT	SUBMA	185.	12.50	33.	8.	8.	.25
+	2 COMBINED AT	CPMA	478.	12.50	81.	23.	22.	.53
+	ROUTED TO	RTMAHB	388.	13.08	81.	22.	22.	.53
+	HYDROGRAPH AT	SUBHB	271.	12.50	46.	12.	11.	.34
+	3 COMBINED AT	CPHB	1944.	14.08	1223.	412.	397.	20.06
+	ROUTED TO	RTHBDA	1939.	14.17	1222.	410.	394.	20.06
+	HYDROGRAPH AT	SUBED	250.	13.00	76.	19.	18.	.48
+	ROUTED TO	RTEDID	120.	16.25	63.	18.	17.	.48
+	HYDROGRAPH AT	SUBID	340.	12.83	84.	21.	20.	.56
+	2 COMBINED AT	CPID	337.	12.83	126.	39.	37.	1.04
+	ROUTED TO	RTIDIC	299.	13.67	119.	38.	36.	1.04
+	HYDROGRAPH AT	SUBIC	244.	13.00	74.	19.	18.	.53
+	2 COMBINED AT	CPIC	483.	13.58	177.	56.	54.	1.57
+	ROUTED TO	RTICDA	433.	14.33	171.	54.	52.	1.57
+	HYDROGRAPH AT	SUBDA	267.	12.58	53.	14.	13.	.33
+	3 COMBINED AT	CPDA	2325.	14.25	1392.	470.	453.	21.96
+	ROUTED TO	RTDACC	2123.	15.58	1354.	439.	423.	21.96
+	HYDROGRAPH AT	SUBEE	704.	12.92	210.	58.	56.	1.43
+	HYDROGRAPH AT	CPEE1	310.	14.75	197.	58.	56.	1.18
+	ROUTED TO	RTDIEE	305.	15.50	193.	57.	54.	1.18
+	2 COMBINED AT	CPEC	704.	12.92	376.	115.	110.	1.43
+	ROUTED TO	RTEEEA	682.	13.42	372.	113.	109.	1.43
+	HYDROGRAPH AT	SUBEA	607.	13.00	186.	47.	45.	1.30
+	2 COMBINED AT	CPEA	1230.	13.25	538.	158.	153.	2.73
+	ROUTED TO	RTEADC	1076.	14.50	518.	152.	147.	2.73

+	HYDROGRAPH AT	SUBDC	545.	12.75	128.	32.	31.	.84
+	2 COMBINED AT	CPDC	1123.	14.42	583.	184.	177.	3.57
+	ROUTED TO	RTDCCC	1028.	15.50	566.	175.	169.	3.57
+	HYDROGRAPH AT	SUBDD	118.	12.33	17.	4.	4.	.13
+	ROUTED TO	RTDDCC	84.	13.33	17.	4.	4.	.13
+	HYDROGRAPH AT	SUBCC	691.	12.67	146.	38.	37.	.98
+	3 COMBINED AT	CPCC1	1042.	15.50	636.	216.	208.	4.68
+	2 COMBINED AT	CPCC2	3068.	15.58	1872.	636.	613.	26.64
+	ROUTED TO	RTCCCB	2979.	16.50	1857.	606.	583.	26.64
+	HYDROGRAPH AT	SUBLB	171.	12.67	34.	9.	8.	.25
+	ROUTED TO	RTLBHA	130.	13.58	34.	9.	8.	.25
+	HYDROGRAPH AT	SUBHA	356.	12.42	59.	15.	15.	.42
+	2 COMBINED AT	CPHA	354.	12.42	91.	24.	23.	.67
+	ROUTED TO	RTHAGD	216.	13.92	88.	23.	22.	.67
+	HYDROGRAPH AT	SUBKC	367.	12.58	67.	17.	16.	.52
+	ROUTED TO	RTKCGD	247.	13.75	65.	17.	16.	.52
+	HYDROGRAPH AT	SUBGD	592.	12.67	135.	34.	33.	.77
+	HYDROGRAPH AT	SUBGC	243.	12.25	31.	9.	8.	.21
+	ROUTED TO	RTGCGD	125.	13.00	31.	9.	8.	.21
+	4 COMBINED AT	CPGD	696.	13.58	308.	81.	78.	2.17
+	ROUTED TO	RTGDCB	627.	14.50	294.	80.	77.	2.17
+	HYDROGRAPH AT	SUBCB	540.	12.92	172.	44.	42.	.74
+	3 COMBINED AT	CPCB	3205.	16.42	2039.	716.	690.	29.55
+	ROUTED TO	RTCBCA	3073.	17.50	2031.	673.	648.	29.55
+	HYDROGRAPH AT	SUBGB	237.	12.25	32.	9.	8.	.23
+	ROUTED TO	RTGBCA	81.	14.42	31.	8.	8.	.23
+	HYDROGRAPH AT	SUBCA	587.	13.08	223.	57.	55.	.97
+	3 COMBINED AT	CPCA	3084.	17.50	2052.	730.	704.	30.75
+	ROUTED TO	RTCABC	3058.	17.83	2050.	714.	688.	30.75
+	HYDROGRAPH AT	SUBBC	235.	13.17	81.	20.	20.	.61
+	2 COMBINED AT	CPBC	3057.	17.83	2051.	732.	705.	31.36

	3 COMBINED AT						
		CDUM	4239.	18.00	3292.	1393.	1341.	63.44
+	HYDROGRAPH AT						
		SUBLC	109.	12.33	14.	4.	3.	.10
+	ROUTED TO						
		RTLCLA	55.	13.42	14.	4.	3.	.10
+	HYDROGRAPH AT						
		SUBLA	266.	12.83	70.	18.	17.	.50
+	2 COMBINED AT						
		CPLA	293.	13.00	84.	21.	21.	.60
+	ROUTED TO						
		RTLAKB	281.	13.33	83.	21.	21.	.60
+	HYDROGRAPH AT						
		SUBKB	322.	12.50	57.	15.	14.	.42
+	2 COMBINED AT						
		CPKB	390.	13.08	138.	36.	34.	1.02
+	HYDROGRAPH AT						
		SUBGA	258.	12.08	18.	5.	5.	.14
+	3 COMBINED AT						
		CDUM	4239.	18.00	3345.	1425.	1373.	64.60
+	HYDROGRAPH AT						
		SUBBB	179.	12.75	43.	11.	10.	.25
+	ROUTED TO						
		RTBBBA	108.	14.58	41.	11.	10.	.25
+	HYDROGRAPH AT						
		SUBBA	161.	12.92	48.	13.	12.	.34
+	2 COMBINED AT						
		CPBA	160.	12.92	86.	23.	22.	.59
+	HYDROGRAPH AT						
		RTBAAA	139.	13.58	61.	16.	15.	.50
+	2 COMBINED AT						
		CPAA	273.	13.17	146.	39.	37.	1.09

*** NORMAL END OF HEC-1 ***

3 COMBINED AT	CPOD3	470.	16.17	320.	114.	110.	13.14
DIVERSION TO	DIOC	85.	16.17	58.	21.	20.	13.14
HYDROGRAPH AT	CPOD4	385.	16.17	263.	93.	90.	13.14
ROUTED TO	RTODMC	349.	17.42	253.	89.	86.	13.14
HYDROGRAPH AT	SUBMC	643.	13.00	221.	57.	55.	1.00
3 COMBINED AT	CPMC1	983.	14.17	603.	203.	196.	16.40
DIVERSION TO	DIMB	375.	14.17	231.	78.	75.	16.40
HYDROGRAPH AT	CPMC2	607.	14.17	372.	125.	120.	16.40
ROUTED TO	RTMCIE	595.	14.50	369.	123.	119.	16.40
HYDROGRAPH AT	SUBEB	137.	12.42	24.	6.	6.	.14
HYDROGRAPH AT	CPEB1	451.	13.00	211.	58.	56.	2.75
2 COMBINED AT	CPEB2	522.	12.83	234.	64.	62.	2.89
ROUTED TO	RTEBIE	506.	13.17	232.	63.	61.	2.89
HYDROGRAPH AT	SUBIE	201.	12.83	62.	16.	15.	.26
2 COMBINED AT	CPIE1	680.	13.08	289.	79.	76.	3.15
ROUTED TO	DETIE	283.	15.00	250.	79.	76.	3.15
DIVERSION TO	DETIER	283.	15.00	250.	79.	76.	3.15
HYDROGRAPH AT	DIVIE	0.	.08	0.	0.	0.	3.15
2 COMBINED AT	CPIE2	595.	14.50	369.	123.	119.	16.80
ROUTED TO	RTIEIB	562.	15.50	357.	116.	112.	16.80
HYDROGRAPH AT	SUBOC	421.	12.25	67.	19.	18.	.31
HYDROGRAPH AT	CPOC1	85.	16.17	58.	21.	20.	13.14
ROUTED TO	RTDIOC	67.	18.58	53.	19.	18.	13.14
2 COMBINED AT	CPOC2	421.	12.25	95.	39.	38.	.31
ROUTED TO	RTOCMB	261.	13.33	88.	37.	35.	.31
HYDROGRAPH AT	SUBMB	631.	12.92	210.	53.	51.	.99
HYDROGRAPH AT	CPMB	375.	14.17	231.	78.	75.	16.40
ROUTED TO	RTDIMB	352.	15.25	223.	74.	71.	16.40
3 COMBINED AT	CPMB1	782.	13.25	439.	155.	150.	18.19
ROUTED TO	RTMBIB	724.	13.83	433.	150.	145.	18.19
DIVERSION TO	DETIBR	250.	12.92	246.	103.	100.	18.19

	HYDROGRAPH AT	DIVIB	474.	13.83	187.	47.	45.	18.19
+	HYDROGRAPH AT	SUBIB	326.	12.92	102.	26.	25.	.46
+	3 COMBINED AT	CPIB	837.	15.25	555.	186.	179.	18.56
+	ROUTED TO	DETIB	448.	16.92	413.	174.	167.	18.56
+	HYDROGRAPH AT	CPIB1A	283.	15.00	250.	79.	76.	3.15
+	HYDROGRAPH AT	CPIB1B	250.	12.92	246.	103.	100.	18.19
+	3 COMBINED AT	CPIB2	949.	16.42	870.	352.	339.	18.56
+	ROUTED TO	RTIBIA	948.	16.50	870.	351.	338.	18.56
+	HYDROGRAPH AT	SUBME	218.	12.67	45.	12.	11.	.32
+	ROUTED TO	RTMEIA	165.	13.50	45.	12.	11.	.32
+	HYDROGRAPH AT	SUBIA	281.	12.50	49.	13.	12.	.31
+	3 COMBINED AT	CPIA	960.	16.33	908.	372.	359.	19.19
+	ROUTED TO	RTIAHB	960.	16.42	908.	369.	355.	19.19
+	DIVERSION TO	DETDAR	660.	16.42	608.	209.	201.	19.19
+	HYDROGRAPH AT	DIVDA	300.	12.50	300.	160.	154.	19.19
+	HYDROGRAPH AT	SUBLD	314.	12.25	48.	15.	14.	.28
+	ROUTED TO	RTLDMA	297.	12.50	48.	15.	14.	.28
+	HYDROGRAPH AT	SUBMA	185.	12.50	33.	8.	8.	.25
+	2 COMBINED AT	CPMA	478.	12.50	81.	23.	22.	.53
+	ROUTED TO	RTMAHB	388.	13.08	81.	22.	22.	.53
+	HYDROGRAPH AT	SUBHB	271.	12.50	46.	12.	11.	.34
+	3 COMBINED AT	CPHB	756.	13.00	406.	191.	184.	20.06
+	ROUTED TO	RTHBDA	746.	13.17	405.	188.	182.	20.06
+	HYDROGRAPH AT	SUBED	250.	13.00	76.	19.	18.	.48
+	ROUTED TO	RTEDID	120.	16.25	63.	18.	17.	.48
+	HYDROGRAPH AT	SUBID	340.	12.83	84.	21.	20.	.56
+	2 COMBINED AT	CPID	337.	12.83	126.	39.	37.	1.04
+	ROUTED TO	RTIDIC	299.	13.67	119.	38.	36.	1.04
+	HYDROGRAPH AT	SUBIC	244.	13.00	74.	19.	18.	.53
+	2 COMBINED AT	CPIC	483.	13.58	177.	56.	54.	1.57
+	ROUTED TO	RTICDA	433.	14.33	171.	54.	52.	1.57

HYDROGRAPH AT	CPDA1A	660.	16.42	608.	209.	201.	19.19
2 COMBINED AT	CPIB2	1028.	14.42	760.	257.	248.	20.76
ROUTED TO	DETDA	414.	20.33	403.	175.	169.	20.76
HYDROGRAPH AT	SUBDA	267.	12.58	53.	14.	13.	.33
3 COMBINED AT	CPDA	962.	13.17	713.	376.	362.	21.96
ROUTED TO	RTDACC	781.	14.92	706.	316.	305.	21.96
HYDROGRAPH AT	SUBEE	704.	12.92	210.	58.	56.	1.43
HYDROGRAPH AT	CPEE1	310.	14.75	197.	58.	56.	1.18
ROUTED TO	RTDIEE	305.	15.50	193.	57.	54.	1.18
2 COMBINED AT	CPEC	704.	12.92	376.	115.	110.	1.43
ROUTED TO	RTEEEA	682.	13.42	372.	113.	109.	1.43
HYDROGRAPH AT	SUBEA	607.	13.00	186.	47.	45.	1.30
2 COMBINED AT	CPEA	1230.	13.25	538.	158.	153.	2.73
ROUTED TO	RTEADC	1076.	14.50	518.	152.	147.	2.73
HYDROGRAPH AT	SUBDC	545.	12.75	128.	32.	31.	.84
2 COMBINED AT	CPDC	1123.	14.42	583.	184.	177.	3.57
ROUTED TO	RTDCCC	1028.	15.50	566.	175.	169.	3.57
HYDROGRAPH AT	SUBDD	118.	12.33	17.	4.	4.	.13
ROUTED TO	RTDDCC	84.	13.33	17.	4.	4.	.13
HYDROGRAPH AT	SUBCC	691.	12.67	146.	38.	37.	.98
3 COMBINED AT	CPCC1	1042.	15.50	636.	216.	208.	4.68
2 COMBINED AT	CPCC2	1684.	15.50	1210.	516.	497.	26.64
ROUTED TO	RTCCCB	1631.	16.42	1202.	469.	452.	26.64
HYDROGRAPH AT	SUBLB	171.	12.67	34.	9.	8.	.25
ROUTED TO	RTLBHA	130.	13.58	34.	9.	8.	.25
HYDROGRAPH AT	SUBHA	356.	12.42	59.	15.	15.	.42
2 COMBINED AT	CPHA	354.	12.42	91.	24.	23.	.67
ROUTED TO	RTHAGD	216.	13.92	88.	23.	22.	.67
HYDROGRAPH AT	SUBKC	367.	12.58	67.	17.	16.	.52
ROUTED TO	RTKCGD	247.	13.75	65.	17.	16.	.52
HYDROGRAPH AT	SUBGD	592.	12.67	135.	34.	33.	.77

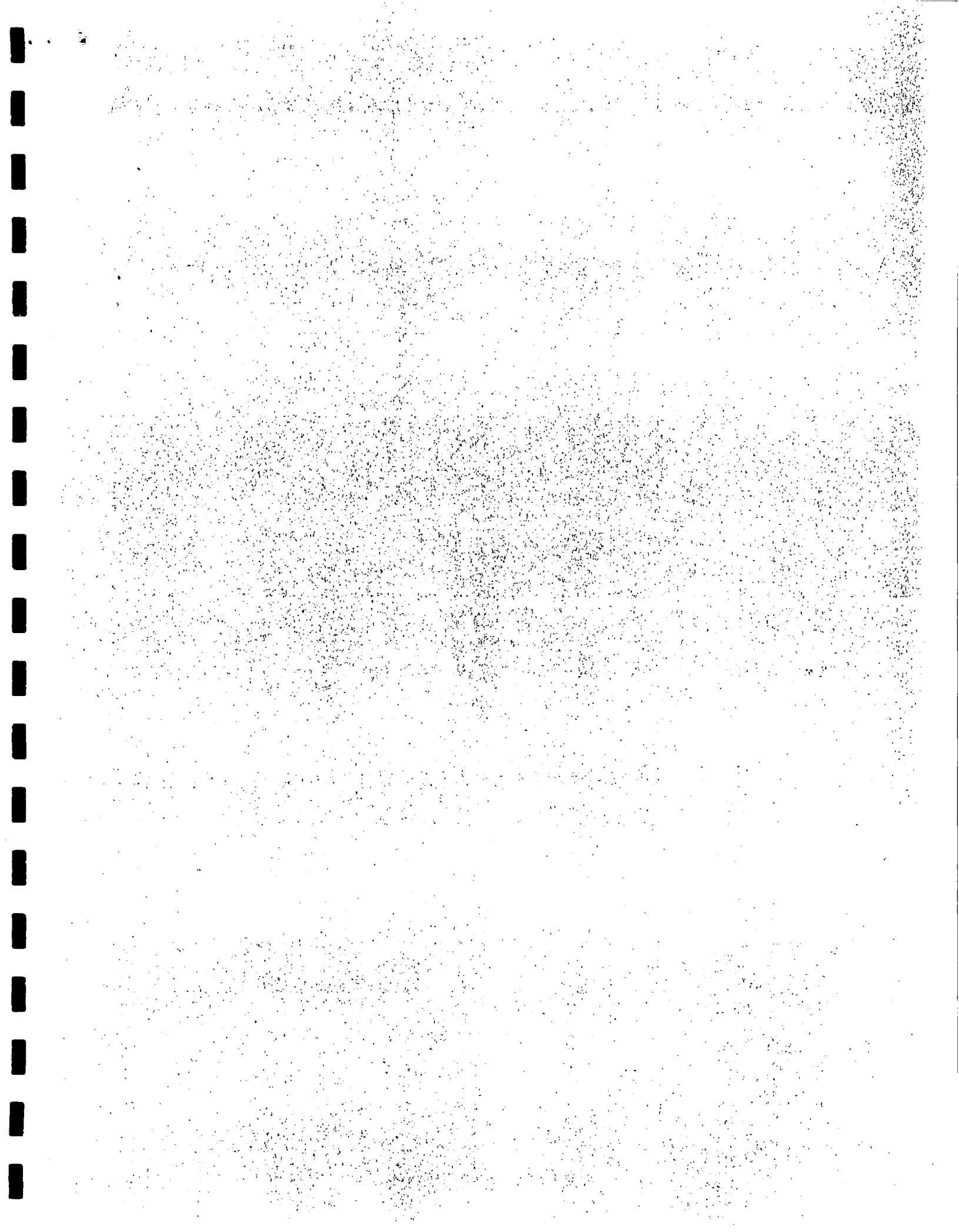
3 COMBINED AT	CPOD3	470.	16.17	320.	114.	110.	13.14
DIVERSION TO	DIOC	85.	16.17	58.	21.	20.	13.14
HYDROGRAPH AT	CPOD4	385.	16.17	263.	93.	90.	13.14
ROUTED TO	RTODMC	349.	17.42	253.	89.	86.	13.14
HYDROGRAPH AT	SUBMC	643.	13.00	221.	57.	55.	1.00
3 COMBINED AT	CPMC1	983.	14.17	603.	203.	196.	16.40
DIVERSION TO	DIMB	375.	14.17	231.	78.	75.	16.40
HYDROGRAPH AT	CPMC2	607.	14.17	372.	125.	120.	16.40
ROUTED TO	RTMCIE	595.	14.50	369.	123.	119.	16.40
HYDROGRAPH AT	SUBEB	137.	12.42	24.	6.	6.	.14
HYDROGRAPH AT	CPEB1	451.	13.00	211.	58.	56.	2.75
2 COMBINED AT	CPEB2	522.	12.83	234.	64.	62.	2.89
ROUTED TO	RTEBIE	506.	13.17	232.	63.	61.	2.89
HYDROGRAPH AT	SUBIE	201.	12.83	62.	16.	15.	.26
2 COMBINED AT	CPIE1	680.	13.08	289.	79.	76.	3.15
2 COMBINED AT	CPIE2	1015.	14.25	628.	198.	191.	16.80
ROUTED TO	RTIEIB	986.	15.00	611.	190.	183.	16.80
HYDROGRAPH AT	SUBOC	421.	12.25	67.	19.	18.	.31
HYDROGRAPH AT	CPOC1	85.	16.17	58.	21.	20.	13.14
ROUTED TO	RTDIOC	67.	18.58	53.	19.	18.	13.14
2 COMBINED AT	CPOC2	421.	12.25	95.	39.	38.	.31
ROUTED TO	RTOCMB	261.	13.33	88.	37.	35.	.31
HYDROGRAPH AT	SUBMB	631.	12.92	210.	53.	51.	.99
HYDROGRAPH AT	CPMB	375.	14.17	231.	78.	75.	16.40
ROUTED TO	RTDIMB	352.	15.25	223.	74.	71.	16.40
3 COMBINED AT	CPMB1	782.	13.25	439.	155.	150.	18.19
ROUTED TO	RTMBIB	724.	13.83	433.	150.	145.	18.19
HYDROGRAPH AT	SUBIB	326.	12.92	102.	26.	25.	.46
3 COMBINED AT	CPIB	1715.	14.00	1076.	363.	350.	18.56
ROUTED TO	RTIBIA	1715.	14.08	1076.	362.	349.	18.56
HYDROGRAPH AT	SUBME	218.	12.67	45.	12.	11.	.32

	ROUTED TO	RTMEIA	165.	13.50	45.	12.	11.	.32
+	HYDROGRAPH AT	SUBIA	281.	12.50	49.	13.	12.	.31
+	3 COMBINED AT	CPIA	1831.	14.00	1131.	384.	370.	19.19
+	ROUTED TO	RTIAHB	1827.	14.17	1130.	381.	367.	19.19
+	HYDROGRAPH AT	SUBLD	314.	12.25	48.	15.	14.	.28
+	ROUTED TO	RTLDMA	297.	12.50	48.	15.	14.	.28
+	HYDROGRAPH AT	SUBMA	185.	12.50	33.	8.	8.	.25
+	2 COMBINED AT	CPMA	478.	12.50	81.	23.	22.	.53
+	ROUTED TO	RTMAHB	388.	13.08	81.	22.	22.	.53
+	HYDROGRAPH AT	SUBHB	271.	12.50	46.	12.	11.	.34
+	3 COMBINED AT	CPHB	1944.	14.08	1223.	412.	397.	20.06
+	ROUTED TO	RTHBDA	1939.	14.17	1222.	410.	394.	20.06
+	HYDROGRAPH AT	SUBED	250.	13.00	76.	19.	18.	.48
+	ROUTED TO	RTEDID	120.	16.25	63.	18.	17.	.48
+	HYDROGRAPH AT	SUBID	340.	12.83	84.	21.	20.	.56
+	2 COMBINED AT	CPID	337.	12.83	126.	39.	37.	1.04
+	ROUTED TO	RTIDIC	299.	13.67	119.	38.	36.	1.04
+	HYDROGRAPH AT	SUBIC	244.	13.00	74.	19.	18.	.53
+	2 COMBINED AT	CPIC	483.	13.58	177.	56.	54.	1.57
+	ROUTED TO	RTICDA	433.	14.33	171.	54.	52.	1.57
+	HYDROGRAPH AT	SUBDA	267.	12.58	53.	14.	13.	.33
+	3 COMBINED AT	CPDA	2325.	14.25	1392.	470.	453.	21.96
+	ROUTED TO	RTDACC	2123.	15.58	1354.	439.	423.	21.96
+	HYDROGRAPH AT	SUBEE	704.	12.92	210.	58.	56.	1.43
+	HYDROGRAPH AT	CPEE1	310.	14.75	197.	58.	56.	1.18
+	ROUTED TO	RTDIEE	305.	15.50	193.	57.	54.	1.18
+	2 COMBINED AT	CPEC	704.	12.92	376.	115.	110.	1.43
+	ROUTED TO	RTEEEA	682.	13.42	372.	113.	109.	1.43
+	HYDROGRAPH AT	SUBEA	607.	13.00	186.	47.	45.	1.30
+	2 COMBINED AT	CPEA	1230.	13.25	538.	158.	153.	2.73
+	ROUTED TO	RTEADC	1076.	14.50	518.	152.	147.	2.73

HYDROGRAPH AT	SUBDC	545.	12.75	128.	32.	31.	.84
2 COMBINED AT	CPDC	1123.	14.42	583.	184.	177.	3.57
ROUTED TO	RTDCCC	1028.	15.50	566.	175.	169.	3.57
HYDROGRAPH AT	SUBDD	118.	12.33	17.	4.	4.	.13
ROUTED TO	RTDDCC	84.	13.33	17.	4.	4.	.13
HYDROGRAPH AT	SUBCC	691.	12.67	146.	38.	37.	.98
3 COMBINED AT	CPCC1	1042.	15.50	636.	216.	208.	4.68
2 COMBINED AT	CPCC2	3068.	15.58	1872.	636.	613.	26.64
ROUTED TO	RTCCCB	2979.	16.50	1857.	606.	583.	26.64
HYDROGRAPH AT	SUBLB	171.	12.67	34.	9.	8.	.25
ROUTED TO	RTLBHA	130.	13.58	34.	9.	8.	.25
HYDROGRAPH AT	SUBHA	356.	12.42	59.	15.	15.	.42
2 COMBINED AT	CPHA	354.	12.42	91.	24.	23.	.67
ROUTED TO	RTHAGD	216.	13.92	88.	23.	22.	.67
HYDROGRAPH AT	SUBKC	367.	12.58	67.	17.	16.	.52
ROUTED TO	RTKCGD	247.	13.75	65.	17.	16.	.52
HYDROGRAPH AT	SUBGD	592.	12.67	135.	34.	33.	.77
HYDROGRAPH AT	SUBGC	243.	12.25	31.	9.	8.	.21
ROUTED TO	RTGCGD	125.	13.00	31.	9.	8.	.21
4 COMBINED AT	CPGD	696.	13.58	308.	81.	78.	2.17
ROUTED TO	RTGDCB	627.	14.50	294.	80.	77.	2.17
HYDROGRAPH AT	SUBCB	540.	12.92	172.	44.	42.	.74
2 COMBINED AT	CPCB	783.	14.00	441.	123.	118.	2.91
ROUTED TO	RTCBCA	735.	15.50	421.	118.	114.	2.91
HYDROGRAPH AT	SUBGB	237.	12.25	32.	9.	8.	.23
ROUTED TO	RTGBCA	81.	14.42	31.	8.	8.	.23
HYDROGRAPH AT	SUBCA	587.	13.08	223.	57.	55.	.97
3 COMBINED AT	CPCA	893.	15.17	613.	183.	176.	4.11
ROUTED TO	RTCABC	886.	15.50	608.	181.	174.	4.11
HYDROGRAPH AT	SUBBC	235.	13.17	81.	20.	20.	.61
2 COMBINED AT	CPBC	914.	15.42	675.	200.	193.	4.72

	3 COMBINED AT	CDUM	3569.	16.42	2694.	1058.	1019.	48.65
+	HYDROGRAPH AT	SUBLC	109.	12.33	14.	4.	3.	.10
+	ROUTED TO	RTLCLA	55.	13.42	14.	4.	3.	.10
+	HYDROGRAPH AT	SUBLA	266.	12.83	70.	18.	17.	.50
+	2 COMBINED AT	CPLA	293.	13.00	84.	21.	21.	.60
+	ROUTED TO	RTLAKB	281.	13.33	83.	21.	21.	.60
+	HYDROGRAPH AT	SUBKB	322.	12.50	57.	15.	14.	.42
+	2 COMBINED AT	CPKB	390.	13.08	138.	36.	34.	1.02
+	HYDROGRAPH AT	SUBGA	258.	12.08	18.	5.	5.	.14
+	3 COMBINED AT	CDUM	3577.	16.42	2714.	1091.	1051.	49.81
+	HYDROGRAPH AT	SUBBB	179.	12.75	43.	11.	10.	.25
+	ROUTED TO	RTBBBA	108.	14.58	41.	11.	10.	.25
+	HYDROGRAPH AT	SUBBA	161.	12.92	48.	13.	12.	.34
+	2 COMBINED AT	CPBA	160.	12.92	86.	23.	22.	.59
+	HYDROGRAPH AT	RTBAAA	139.	13.58	61.	16.	15.	.50
+	2 COMBINED AT	CPAA	273.	13.17	146.	39.	37.	1.09

*** NORMAL END OF HEC-1 ***



3 COMBINED AT										
+	CPOD3	.53	1	FLOW	106.	211.	267.	368.	471.	579.
				TIME	12.67	12.67	12.67	12.67	16.17	15.92
DIVERSION TO										
+	DIOC	.53	1	FLOW	19.	38.	48.	66.	85.	104.
				TIME	12.67	12.67	12.67	12.67	16.17	15.92
HYDROGRAPH AT										
+	CPOD4	.53	1	FLOW	87.	173.	219.	301.	386.	475.
				TIME	12.67	12.67	12.67	12.67	16.17	15.92
ROUTED TO										
+	RTODMC	.53	1	FLOW	42.	101.	141.	227.	351.	438.
				TIME	15.08	14.58	14.25	18.08	17.42	17.08
			** PEAK STAGES IN FEET **							
			1	STAGE	.85	1.17	1.30	1.52	1.76	1.90
				TIME	15.08	14.58	14.25	18.08	17.42	17.08
HYDROGRAPH AT										
+	SUBMC	1.00	1	FLOW	150.	305.	387.	532.	618.	674.
				TIME	13.00	13.00	13.00	13.00	13.00	13.00
3 COMBINED AT										
+	CPMC1	2.99	1	FLOW	151.	352.	504.	802.	994.	1121.
				TIME	13.00	14.58	14.33	14.17	14.08	14.08
DIVERSION TO										
+	DIMB	2.99	1	FLOW	59.	136.	194.	307.	380.	428.
				TIME	13.00	14.58	14.33	14.17	14.08	14.08
HYDROGRAPH AT										
+	CPMC2	2.99	1	FLOW	92.	216.	311.	495.	615.	693.
				TIME	13.00	14.58	14.33	14.17	14.08	14.08
ROUTED TO										
+	RTMCIE	2.99	1	FLOW	77.	205.	295.	480.	602.	682.
				TIME	13.75	15.00	14.75	14.50	14.42	14.42
			** PEAK STAGES IN FEET **							
			1	STAGE	1.02	1.41	1.58	1.87	2.03	2.12
				TIME	13.75	15.00	14.75	14.50	14.42	14.42
HYDROGRAPH AT										
+	SUBEB	.14	1	FLOW	34.	65.	81.	111.	129.	141.
				TIME	12.50	12.42	12.42	12.42	12.42	12.42
HYDROGRAPH AT										
+	CPEB1	.00	1	FLOW	105.	217.	274.	377.	438.	478.
				TIME	13.08	13.00	13.00	13.00	13.00	13.00
2 COMBINED AT										
+	CPEB2	.14	1	FLOW	120.	248.	314.	434.	506.	553.
				TIME	12.83	12.83	12.83	12.83	12.83	12.83
ROUTED TO										
+	RTEBIE	.14	1	FLOW	107.	237.	302.	420.	491.	538.
				TIME	13.50	13.25	13.25	13.25	13.17	13.17
			** PEAK STAGES IN FEET **							
			1	STAGE	1.18	1.52	1.64	1.84	1.95	2.01
				TIME	13.50	13.25	13.25	13.25	13.17	13.17
HYDROGRAPH AT										
+	SUBIE	.26	1	FLOW	53.	101.	124.	166.	191.	207.
				TIME	12.83	12.83	12.83	12.83	12.83	12.83
3 COMBINED AT										
+	CPIE	3.39	1	FLOW	211.	477.	612.	864.	1010.	1123.
				TIME	13.50	13.33	13.25	13.25	13.25	14.08
ROUTED TO										
+	RTIEIB	3.39	1	FLOW	170.	412.	545.	796.	968.	1098.
				TIME	15.08	14.50	14.42	14.33	14.83	14.83
			** PEAK STAGES IN FEET **							
			1	STAGE	1.41	1.90	2.11	2.43	2.62	2.75
				TIME	15.08	14.50	14.42	14.33	14.83	14.83
HYDROGRAPH AT										
+	SUBOC	.31	1	FLOW	105.	200.	252.	345.	400.	435.
				TIME	12.33	12.25	12.25	12.25	12.25	12.25
HYDROGRAPH AT										
+	CPOC1	.00	1	FLOW	19.	38.	48.	66.	85.	104.
				TIME	12.67	12.67	12.67	12.67	16.17	15.92
ROUTED TO										
+	RTDIOC	.00	1	FLOW	6.	14.	20.	44.	67.	85.
				TIME	16.75	16.00	15.83	19.42	18.58	17.92
			** PEAK STAGES IN FEET **							

			1	STAGE	.43	.64	.76	1.02	1.18	1.27
				TIME	16.83	16.00	15.83	19.42	18.58	17.92
2 COMBINED AT										
+	CPOC2	.31	1	FLOW	106.	200.	252.	345.	400.	436.
				TIME	12.33	12.25	12.25	12.25	12.25	12.25
ROUTED TO										
+	RTOCMB	.31	1	FLOW	39.	91.	124.	195.	242.	274.
				TIME	14.25	13.83	13.75	13.42	13.42	13.33
			** PEAK STAGES IN FEET **							
			1	STAGE	.76	1.04	1.15	1.33	1.43	1.49
				TIME	14.25	13.83	13.75	13.42	13.42	13.33
HYDROGRAPH AT										
+	SUBMB	.99	1	FLOW	133.	292.	374.	520.	606.	662.
				TIME	13.08	13.08	13.08	13.00	13.00	12.92
HYDROGRAPH AT										
+	CPMB	.00	1	FLOW	59.	136.	194.	307.	380.	428.
				TIME	13.00	14.58	14.33	14.17	14.08	14.08
ROUTED TO										
+	RTDIMB	.00	1	FLOW	41.	117.	172.	282.	355.	404.
				TIME	17.42	16.08	15.67	15.33	15.17	15.17
			** PEAK STAGES IN FEET **							
			1	STAGE	.84	1.24	1.39	1.63	1.76	1.84
				TIME	17.42	16.08	15.67	15.33	15.17	15.17
3 COMBINED AT										
+	CPMB1	1.30	1	FLOW	135.	313.	429.	662.	799.	895.
				TIME	13.08	13.42	13.42	13.42	13.25	13.17
ROUTED TO										
+	RTMBIB	1.30	1	FLOW	110.	291.	397.	608.	740.	826.
				TIME	14.17	14.00	13.92	13.83	13.83	13.75
			** PEAK STAGES IN FEET **							
			1	STAGE	1.29	1.77	1.98	2.31	2.50	2.60
				TIME	14.17	14.00	13.92	13.83	13.83	13.75
HYDROGRAPH AT										
+	SUBIB	.46	1	FLOW	84.	162.	200.	269.	311.	338.
				TIME	12.92	12.92	12.83	12.92	12.92	12.92
3 COMBINED AT										
+	CPIB	5.15	1	FLOW	266.	700.	959.	1449.	1751.	1949.
				TIME	15.00	14.42	14.25	14.08	14.00	14.00
ROUTED TO										
+	RTIBIA	5.15	1	FLOW	265.	699.	957.	1446.	1751.	1946.
				TIME	15.08	14.42	14.25	14.08	14.08	14.08
			** PEAK STAGES IN FEET **							
			1	STAGE	1.24	1.68	1.87	2.17	2.33	2.43
				TIME	15.08	14.42	14.25	14.08	14.08	14.08
HYDROGRAPH AT										
+	SUBME	.32	1	FLOW	33.	82.	114.	169.	205.	228.
				TIME	12.67	12.67	12.67	12.67	12.67	12.67
ROUTED TO										
+	RTMEIA	.32	1	FLOW	17.	51.	74.	121.	152.	174.
				TIME	14.33	13.92	13.83	13.67	13.50	13.42
			** PEAK STAGES IN FEET **							
			1	STAGE	.55	.85	1.00	1.17	1.26	1.31
				TIME	14.33	13.92	13.83	13.67	13.50	13.42
HYDROGRAPH AT										
+	SUBIA	.31	1	FLOW	47.	111.	150.	223.	265.	292.
				TIME	12.50	12.50	12.50	12.50	12.50	12.50
3 COMBINED AT										
+	CPIA	5.78	1	FLOW	279.	743.	1022.	1547.	1875.	2085.
				TIME	15.00	14.42	14.25	14.08	14.00	14.00
ROUTED TO										
+	RTIAHB	5.78	1	FLOW	277.	739.	1018.	1542.	1870.	2081.
				TIME	15.25	14.58	14.42	14.17	14.17	14.08
			** PEAK STAGES IN FEET **							
			1	STAGE	1.41	2.03	2.26	2.61	2.79	2.90
				TIME	15.25	14.58	14.42	14.17	14.17	14.08
HYDROGRAPH AT										
+	SUBLD	.28	1	FLOW	58.	129.	168.	247.	295.	326.
				TIME	12.33	12.33	12.33	12.25	12.25	12.25
ROUTED TO										
+	RTLDMA	.28	1	FLOW	49.	112.	152.	227.	275.	311.

				TIME	12.67	12.67	12.58	12.58	12.50	12.50
				** PEAK STAGES IN FEET **						
			1	STAGE	.56	.77	.85	.99	1.07	1.10
				TIME	12.67	12.67	12.58	12.58	12.50	12.50
HYDROGRAPH AT										
+	SUBMA	.25	1	FLOW	40.	80.	103.	146.	174.	191.
				TIME	12.58	12.50	12.50	12.50	12.50	12.50
2 COMBINED AT										
+	CPMA	.53	1	FLOW	87.	191.	255.	373.	449.	502.
				TIME	12.67	12.58	12.58	12.58	12.50	12.50
ROUTED TO										
+	RTMAHB	.53	1	FLOW	58.	138.	184.	297.	364.	410.
				TIME	13.67	13.42	13.33	13.17	13.08	13.08
				** PEAK STAGES IN FEET **						
			1	STAGE	.78	1.07	1.19	1.38	1.48	1.53
				TIME	13.67	13.42	13.33	13.17	13.08	13.08
HYDROGRAPH AT										
+	SUBHB	.34	1	FLOW	38.	101.	141.	211.	255.	282.
				TIME	12.50	12.50	12.50	12.50	12.50	12.50
3 COMBINED AT										
+	CPHB	6.65	1	FLOW	293.	788.	1088.	1647.	1996.	2221.
				TIME	15.25	14.50	14.33	14.17	14.08	14.00
ROUTED TO										
+	RTHBDA	6.65	1	FLOW	291.	784.	1082.	1641.	1991.	2214.
				TIME	15.33	14.67	14.42	14.25	14.17	14.08
				** PEAK STAGES IN FEET **						
			1	STAGE	1.30	1.80	2.02	2.35	2.53	2.64
				TIME	15.33	14.67	14.42	14.25	14.17	14.08
HYDROGRAPH AT										
+	SUBED	.48	1	FLOW	58.	114.	143.	200.	237.	261.
				TIME	13.00	13.00	13.00	13.00	13.00	13.00
ROUTED TO										
+	RTEDID	.48	1	FLOW	16.	39.	52.	86.	111.	127.
				TIME	19.17	17.83	17.17	16.58	16.33	16.25
				** PEAK STAGES IN FEET **						
			1	STAGE	.82	1.14	1.26	1.48	1.60	1.67
				TIME	19.17	17.83	17.17	16.58	16.33	16.25
HYDROGRAPH AT										
+	SUBID	.56	1	FLOW	49.	129.	179.	269.	322.	357.
				TIME	12.83	12.83	12.83	12.83	12.83	12.83
2 COMBINED AT										
+	CPID	1.04	1	FLOW	49.	129.	179.	269.	322.	357.
				TIME	12.83	12.83	12.83	12.83	12.83	12.83
ROUTED TO										
+	RTIDIC	1.04	1	FLOW	32.	99.	146.	232.	284.	318.
				TIME	14.58	14.17	13.92	13.75	13.67	13.67
				** PEAK STAGES IN FEET **						
			1	STAGE	.62	.96	1.11	1.30	1.39	1.45
				TIME	14.58	14.17	13.92	13.75	13.67	13.67
HYDROGRAPH AT										
+	SUBIC	.53	1	FLOW	30.	88.	125.	192.	231.	256.
				TIME	13.00	13.00	13.00	13.00	13.00	13.00
2 COMBINED AT										
+	CPIC	1.57	1	FLOW	40.	141.	221.	368.	460.	518.
				TIME	14.42	13.92	13.83	13.58	13.58	13.58
ROUTED TO										
+	RTICDA	1.57	1	FLOW	33.	121.	186.	327.	411.	467.
				TIME	16.17	15.17	14.83	14.50	14.33	14.33
				** PEAK STAGES IN FEET **						
			1	STAGE	.64	1.07	1.25	1.49	1.60	1.67
				TIME	16.17	15.17	14.83	14.50	14.33	14.33
HYDROGRAPH AT										
+	SUBDA	.33	1	FLOW	42.	103.	142.	211.	252.	278.
				TIME	12.58	12.58	12.58	12.58	12.58	12.58
3 COMBINED AT										
+	CPDA	8.55	1	FLOW	318.	880.	1240.	1957.	2398.	2680.
				TIME	15.42	14.75	14.50	14.33	14.25	14.17
ROUTED TO										
+	RTDACC	8.55	1	FLOW	277.	777.	1104.	1760.	2175.	2448.
				TIME	17.42	16.33	16.08	15.83	15.67	15.67

				** PEAK STAGES IN FEET **						
			1	STAGE	2.05	3.04	3.50	4.23	4.61	4.85
				TIME	17.42	16.33	16.08	15.83	15.67	15.67
HYDROGRAPH AT										
+	SUBEE	1.43	1	FLOW	102.	265.	363.	554.	673.	749.
				TIME	12.92	12.92	12.92	12.92	12.92	12.92
HYDROGRAPH AT										
+	CPEE1	.00	1	FLOW	45.	104.	146.	233.	291.	329.
				TIME	12.92	15.00	15.00	14.83	14.75	14.75
ROUTED TO										
+	RTDIEE	.00	1	FLOW	36.	101.	144.	230.	287.	324.
				TIME	17.33	16.17	15.92	15.58	15.50	15.42
				** PEAK STAGES IN FEET **						
			1	STAGE	.54	.80	.89	1.07	1.15	1.20
				TIME	17.33	16.17	15.92	15.58	15.50	15.42
2 COMBINED AT										
+	CPEC	1.43	1	FLOW	102.	265.	363.	554.	673.	749.
				TIME	12.92	12.92	12.92	12.92	12.92	12.92
ROUTED TO										
+	RTEEEA	1.43	1	FLOW	93.	251.	346.	532.	652.	727.
				TIME	13.83	13.58	13.50	13.42	13.42	13.42
				** PEAK STAGES IN FEET **						
			1	STAGE	.83	1.18	1.32	1.54	1.66	1.73
				TIME	13.83	13.58	13.50	13.42	13.42	13.42
HYDROGRAPH AT										
+	SUBEA	1.30	1	FLOW	103.	248.	334.	489.	581.	642.
				TIME	13.00	13.00	13.00	13.00	13.00	13.00
2 COMBINED AT										
+	CPEA	2.73	1	FLOW	169.	459.	631.	972.	1186.	1320.
				TIME	13.67	13.50	13.33	13.25	13.25	13.25
ROUTED TO										
+	RTEADC	2.73	1	FLOW	124.	372.	531.	841.	1035.	1162.
				TIME	15.58	14.83	14.75	14.58	14.50	14.42
				** PEAK STAGES IN FEET **						
			1	STAGE	1.37	1.99	2.26	2.69	2.92	3.06
				TIME	15.58	14.83	14.75	14.58	14.50	14.42
HYDROGRAPH AT										
+	SUBDC	.84	1	FLOW	90.	218.	297.	436.	519.	574.
				TIME	12.75	12.75	12.75	12.75	12.75	12.75
2 COMBINED AT										
+	CPDC	3.57	1	FLOW	125.	381.	550.	877.	1082.	1221.
				TIME	15.58	14.83	14.67	14.50	14.42	14.42
ROUTED TO										
+	RTDCCC	3.57	1	FLOW	100.	333.	486.	793.	988.	1118.
				TIME	17.75	16.25	16.00	15.67	15.50	15.50
				** PEAK STAGES IN FEET **						
			1	STAGE	1.26	1.86	2.13	2.56	2.79	2.93
				TIME	17.75	16.25	16.00	15.67	15.50	15.50
HYDROGRAPH AT										
+	SUBDD	.13	1	FLOW	12.	41.	58.	90.	110.	122.
				TIME	12.42	12.42	12.33	12.33	12.33	12.33
ROUTED TO										
+	RTDDCC	.13	1	FLOW	5.	23.	36.	62.	77.	86.
				TIME	14.42	13.75	13.50	13.33	13.33	13.33
				** PEAK STAGES IN FEET **						
			1	STAGE	.25	.45	.55	.66	.73	.77
				TIME	14.42	13.75	13.50	13.33	13.33	13.33
HYDROGRAPH AT										
+	SUBCC	.98	1	FLOW	101.	257.	358.	547.	659.	731.
				TIME	12.67	12.67	12.67	12.67	12.67	12.67
3 COMBINED AT										
+	CPCC1	4.68	1	FLOW	101.	337.	495.	809.	1007.	1139.
				TIME	12.67	16.25	15.92	15.67	15.50	15.50
2 COMBINED AT										
+	CPCC2	13.23	1	FLOW	375.	1113.	1593.	2561.	3174.	3579.
				TIME	17.58	16.33	16.00	15.75	15.58	15.58
ROUTED TO										
+	RTCCCB	13.23	1	FLOW	361.	1073.	1539.	2483.	3086.	3487.
				TIME	18.83	17.33	17.08	16.67	16.50	16.42
				** PEAK STAGES IN FEET **						

			1	STAGE	1.85	2.78	3.21	3.89	4.25	4.47
				TIME	18.83	17.33	17.08	16.67	16.50	16.42
HYDROGRAPH AT										
+	SUBLB	.25	1	FLOW	38.	75.	96.	136.	161.	178.
				TIME	12.67	12.67	12.67	12.67	12.67	12.67
ROUTED TO										
+	RTLBHA	.25	1	FLOW	21.	48.	64.	97.	121.	136.
				TIME	14.25	13.92	13.83	13.67	13.58	13.58
			** PEAK STAGES IN FEET **							
			1	STAGE	.59	.83	.92	1.08	1.15	1.19
				TIME	14.25	13.92	13.83	13.67	13.58	13.58
HYDROGRAPH AT										
+	SUBHA	.42	1	FLOW	58.	139.	191.	282.	337.	372.
				TIME	12.50	12.50	12.42	12.42	12.42	12.42
2 COMBINED AT										
+	CPHA	.67	1	FLOW	58.	139.	191.	282.	337.	372.
				TIME	12.50	12.50	12.42	12.42	12.42	12.42
ROUTED TO										
+	RTHAGD	.67	1	FLOW	22.	63.	98.	161.	203.	230.
				TIME	15.50	14.42	14.17	14.00	13.92	13.83
			** PEAK STAGES IN FEET **							
			1	STAGE	.72	1.07	1.23	1.47	1.60	1.67
				TIME	15.50	14.42	14.17	14.00	13.92	13.83
HYDROGRAPH AT										
+	SUBKC	.52	1	FLOW	63.	147.	199.	289.	347.	384.
				TIME	12.58	12.58	12.58	12.58	12.58	12.58
ROUTED TO										
+	RTKCGD	.52	1	FLOW	26.	75.	112.	178.	231.	262.
				TIME	14.92	14.42	14.17	13.83	13.75	13.67
			** PEAK STAGES IN FEET **							
			1	STAGE	.61	.95	1.09	1.28	1.38	1.44
				TIME	14.92	14.42	14.17	13.83	13.75	13.67
HYDROGRAPH AT										
+	SUBGD	.77	1	FLOW	103.	249.	333.	478.	565.	621.
				TIME	12.67	12.67	12.67	12.67	12.67	12.67
HYDROGRAPH AT										
+	SUBGC	.21	1	FLOW	29.	89.	120.	187.	227.	252.
				TIME	12.33	12.25	12.25	12.25	12.25	12.25
ROUTED TO										
+	RTGCGD	.21	1	FLOW	9.	34.	48.	86.	112.	133.
				TIME	13.83	13.42	13.33	13.17	13.00	13.00
			** PEAK STAGES IN FEET **							
			1	STAGE	.50	.83	.96	1.17	1.28	1.34
				TIME	13.83	13.42	13.33	13.17	13.00	13.00
4 COMBINED AT										
+	CPGD	2.17	1	FLOW	105.	258.	347.	521.	658.	763.
				TIME	12.67	12.67	12.67	12.75	13.58	13.58
ROUTED TO										
+	RTGDCB	2.17	1	FLOW	49.	166.	258.	458.	595.	686.
				TIME	16.58	14.58	14.92	14.58	14.50	14.42
			** PEAK STAGES IN FEET **							
			1	STAGE	1.06	1.57	1.82	2.25	2.48	2.62
				TIME	16.58	14.58	14.92	14.58	14.50	14.42
HYDROGRAPH AT										
+	SUBCB	.74	1	FLOW	124.	259.	327.	448.	518.	563.
				TIME	12.92	12.92	12.92	12.92	12.92	12.92
3 COMBINED AT										
+	CPCB	16.14	1	FLOW	397.	1164.	1667.	2681.	3334.	3768.
				TIME	18.83	17.33	17.00	16.58	16.42	16.33
ROUTED TO										
+	RTCBCA	16.14	1	FLOW	375.	1097.	1573.	2544.	3169.	3586.
				TIME	20.67	18.83	18.33	17.83	17.67	17.58
			** PEAK STAGES IN FEET **							
			1	STAGE	2.24	3.41	3.95	4.80	5.28	5.60
				TIME	20.67	18.83	18.33	17.83	17.67	17.58
HYDROGRAPH AT										
+	SUBGB	.23	1	FLOW	24.	84.	115.	181.	221.	247.
				TIME	12.33	12.33	12.33	12.33	12.25	12.25
ROUTED TO										
+	RTGBCA	.23	1	FLOW	5.	21.	31.	56.	74.	85.

				TIME	16.50	15.33	15.00	14.67	14.42	14.33
				** PEAK STAGES IN FEET **						
			1	STAGE	.35	.65	.77	.98	1.07	1.12
				TIME	16.50	15.33	15.00	14.67	14.42	14.33
HYDROGRAPH AT										
+	SUBCA	.97	1	FLOW	153.	294.	364.	489.	565.	614.
				TIME	13.17	13.08	13.08	13.08	13.08	13.08
3 COMBINED AT										
+	CPCA	17.34	1	FLOW	377.	1102.	1585.	2562.	3191.	3613.
				TIME	20.67	18.83	18.33	17.83	17.67	17.58
ROUTED TO										
+	RTCABC	17.34	1	FLOW	372.	1092.	1569.	2540.	3167.	3588.
				TIME	21.25	19.25	18.75	18.17	18.00	17.92
				** PEAK STAGES IN FEET **						
			1	STAGE	1.96	2.96	3.40	4.09	4.46	4.67
				TIME	21.25	19.25	18.75	18.17	18.00	17.92
HYDROGRAPH AT										
+	SUBBC	.61	1	FLOW	25.	80.	116.	182.	222.	247.
				TIME	13.17	13.17	13.17	13.17	13.17	13.17
2 COMBINED AT										
+	CPBC	17.95	1	FLOW	372.	1092.	1571.	2543.	3171.	3592.
				TIME	21.25	19.25	18.75	18.17	18.00	17.92
3 COMBINED AT										
+	CDUM	52.73	1	FLOW	638.	1524.	2115.	3761.	4909.	5672.
				TIME	13.42	13.33	18.58	18.42	18.00	17.92
HYDROGRAPH AT										
+	SUBLC	.10	1	FLOW	21.	46.	60.	86.	102.	112.
				TIME	12.33	12.33	12.33	12.33	12.33	12.33
ROUTED TO										
+	RTLCLA	.10	1	FLOW	7.	18.	26.	40.	51.	57.
				TIME	14.00	13.67	13.58	13.42	13.42	13.33
				** PEAK STAGES IN FEET **						
			1	STAGE	.33	.53	.61	.74	.80	.84
				TIME	14.00	13.67	13.58	13.42	13.42	13.33
HYDROGRAPH AT										
+	SUBLA	.50	1	FLOW	45.	106.	144.	210.	252.	278.
				TIME	12.92	12.83	12.83	12.83	12.83	12.83
2 COMBINED AT										
+	CPLA	.60	1	FLOW	46.	109.	150.	227.	277.	308.
				TIME	12.92	12.92	12.92	13.00	13.00	13.00
ROUTED TO										
+	RTLAKB	.60	1	FLOW	39.	99.	140.	215.	265.	296.
				TIME	13.75	13.58	13.50	13.42	13.33	13.33
				** PEAK STAGES IN FEET **						
			1	STAGE	.65	.96	1.08	1.26	1.33	1.38
				TIME	13.75	13.58	13.50	13.42	13.33	13.33
HYDROGRAPH AT										
+	SUBKB	.42	1	FLOW	34.	112.	159.	248.	303.	337.
				TIME	12.58	12.50	12.50	12.50	12.50	12.50
2 COMBINED AT										
+	CPKB	1.02	1	FLOW	43.	121.	179.	290.	367.	422.
				TIME	13.67	13.33	13.17	12.92	13.08	13.00
HYDROGRAPH AT										
+	SUBGA	.14	1	FLOW	20.	93.	132.	200.	241.	266.
				TIME	12.08	12.08	12.08	12.08	12.08	12.08
3 COMBINED AT										
+	CDUM	53.89	1	FLOW	680.	1646.	2221.	3765.	4916.	5680.
				TIME	13.42	13.33	13.33	18.42	18.00	17.92
HYDROGRAPH AT										
+	SUBBB	.25	1	FLOW	29.	71.	97.	142.	169.	186.
				TIME	12.75	12.75	12.75	12.75	12.75	12.75
ROUTED TO										
+	RTBBBA	.25	1	FLOW	10.	33.	49.	81.	101.	113.
				TIME	16.25	15.33	15.08	14.75	14.67	14.58
				** PEAK STAGES IN FEET **						
			1	STAGE	.49	.78	.90	1.08	1.17	1.23
				TIME	16.25	15.33	15.08	14.75	14.67	14.58
HYDROGRAPH AT										
+	SUBBA	.34	1	FLOW	21.	57.	81.	124.	151.	168.
				TIME	13.00	13.00	13.00	12.92	12.92	12.92

2 COMBINED AT										
+	CPBA	.59	1	FLOW	21.	57.	81.	124.	151.	168.
				TIME	13.00	13.00	13.00	12.92	12.92	12.92
HYDROGRAPH AT										
+	RTBAAA	.50	1	FLOW	13.	46.	67.	106.	130.	146.
				TIME	13.50	13.50	13.50	13.50	13.58	13.58
2 COMBINED AT										
+	CPAA	1.09	1	FLOW	32.	95.	135.	212.	260.	290.
				TIME	13.25	13.17	13.17	13.17	13.17	13.17

*** NORMAL END OF HEC-1 ***

CULVERT DESIGN CALCULATIONS

Description	Discharge Qt (cfs)	Discharge 100yr (cfs)	No. of Barrels	Culvert Diam./ Height	Unit	Box/ Arch Wid.	Mat'l	Barrel/ Entrance	Length (ft)	Invert Elev. Inlet (ft)	Invert Elev. Outlet (ft)	Barrel Slope (%)	TW Depth (ft)	Allowable HW (ft)	Allowable HW/D	HW/D Qt		HW/D Q100	Controlling HW
115th Ave Drainage Improvements																			
Alt. 1 - Detention																			
99th Ave Det. Basin outfall	283	283	2	42	in.		RCP	headwall	260	968.00	963.60	1.69%	3.8	978.0	2.86	2.54	*	2.54	IC
107th Ave Det. Basin outfall	448	448	2	60	in.		RCP	headwall	200	959.00	956.40	1.30%	4.9	966.0	1.40	1.50	*	1.50	IC
107th Ave Crossing (2 flow-by's)	533	533	1	5	ft.	8	RCBC	Wingwall	200	958.00	956.40	0.80%	4.9	966.0	1.60	2.18	*	2.18	IC
107th Ave farm road access	725	725	2	5	ft.	8	RCBC	Wingwall	30	959.15	959.00	0.50%	5.5	966.0	1.37	1.45		1.45	TW
Farm Rd @115th Ave & BFC	300	300	1	5	ft.	8	RCBC	Wingwall	30	950.00	946.00	13.33%	4.9	956.0	1.20	1.14		1.14	IC
Broadway Rd @ 115th Ave	962	962	2	6	ft.	10	RCBC	Wingwall	80	938.41	938.01	0.50%	6.5	945.0	1.10	1.27		1.27	TW
Farm Rd "1", S. of Broadway	962	962	2	6	ft.	10	RCBC	Wingwall	35	935.89	935.71	0.51%	7.3	943.5	1.27	1.44		1.44	TW
Farm Rd "2", S. of Broadway	962	962	2	6	ft.	10	RCBC	Wingwall	35	935.24	935.06	0.51%	6.5	942.8	1.26	1.30		1.30	TW
"Roeser Rd" - S. of Broadway	962	962	2	6	ft.	10	RCBC	Wingwall	70	933.48	933.13	0.50%	6.9	941.5	1.34	1.35		1.35	TW
Farm Rd "3", S. of Broadway	962	962	2	6	ft.	10	RCBC	Wingwall	40	932.14	931.94	0.50%	6.6	940.0	1.31	1.32		1.32	TW
115th Ave Crossing	1684	1684	3	8	ft.	10	RCBC	Wingwall	160	931.00	930.40	0.38%	6.9	940.0	1.13	0.95		0.95	TW
Southern Ave Crossing	1600	1600	2	8	ft.	12	RCBC	Wingwall	80	928.20	928.13	0.09%	6.9	940.0	1.47	1.06		1.06	TW
El Mirage Rd Crossing	783	783	2	6	ft.	8	RCBC	Wingwall	80	926.00	925.50	0.63%	5.3	934.0	1.33	1.14		1.14	IC
Dysart Rd. Crossing	893	893	2	6	ft.	8	RCBC	Wingwall	80	917.80	917.50	0.37%	5.2	926.0	1.37	1.37		1.37	IC
Alt. 2 - Conveyance																			
Broadway Rd @ 115th Ave	2450	2450	3	8	ft.	10	RCBC	Wingwall	80	936.55	936.41	0.17%	11.2	945.0	1.06	1.68		1.68	TW
Farm Rd "1", S. of Broadway	2450	2450	3	8	ft.	10	RCBC	Wingwall	35	934.29	934.23	0.17%	11.0	943.5	1.15	1.66		1.66	TW
Farm Rd "2", S. of Broadway	2450	2450	3	8	ft.	12	RCBC	Wingwall	35	933.75	933.69	0.17%	9.9	942.8	1.13	1.43		1.43	TW
"Roeser Rd" - S. of Broadway	2450	2450	3	8	ft.	12	RCBC	Wingwall	70	932.11	931.99	0.17%	9.9	941.5	1.17	1.44		1.44	TW
Farm Rd "3", S. of Broadway	2450	2450	3	8	ft.	12	RCBC	Wingwall	40	931.01	930.94	0.17%	9.4	940.0	1.12	1.36		1.36	TW
115th Ave Crossing	3178	3178	4	8	ft.	10	RCBC	Wingwall	160	930.44	930.30	0.09%	7.5	940.0	1.19	1.23		1.23	TW
Southern Ave Crossing	3100	3178	4	8	ft.	12	RCBC	Wingwall	80	928.20	928.13	0.09%	7.4	940.0	1.47	1.11		1.12	TW
El Mirage Rd Crossing	783	783	2	6	ft.	8	RCBC	Wingwall	80	926.00	925.50	0.63%	5.3	934.0	1.33	1.14		1.14	IC
Dysart Rd. Crossing	893	893	2	6	ft.	8	RCBC	Wingwall	80	917.80	917.50	0.37%	5.2	926.0	1.37	1.37		1.37	IC
Alt. 3 - 10 yr. Conveyance																			
Broadway Rd @ 115th Ave	1240	1240	2	8	ft.	8	RCBC	Wingwall	80	937.00	936.60	0.50%	10.2	946.0	1.13	1.51		1.51	TW
Farm Rd "1", S. of Broadway	1240	1240	2	8	ft.	8	RCBC	Wingwall	35	934.48	934.30	0.51%	10.4	943.5	1.13	1.55		1.55	TW
Farm Rd "2", S. of Broadway	1240	1240	2	8	ft.	10	RCBC	Wingwall	35	933.82	933.64	0.51%	9.7	942.8	1.13	1.36		1.36	TW
"Roeser Rd" - S. of Broadway	1240	1240	2	8	ft.	8	RCBC	Wingwall	70	932.06	931.70	0.51%	9.5	941.1	1.13	1.41		1.41	TW
Farm Rd "3", S. of Broadway	1240	1240	2	8	ft.	8	RCBC	Wingwall	40	930.70	930.50	0.50%	8.5	939.7	1.13	1.31		1.31	TW
115th Ave Crossing	1593	1593	2	8	ft.	10	RCBC	Wingwall	160	929.56	929.50	0.04%	6.8	938.6	1.13	1.18		1.18	IC
El Mirage Rd Crossing	1593	1593	2	8	ft.	12	RCBC	Wingwall	70	925.72	925.32	0.57%	6.1	934.7	1.13	1.04		1.04	IC
Dysart Rd Crossing	1593	1593	2	8	ft.	12	RCBC	Wingwall	70	917.69	917.29	0.57%	6.1	926.7	1.13	1.04		1.04	IC

CHANNEL CALCULATIONS

Concrete	Mannings n =	0.013	C
Earth	Mannings n =	0.025	E
Grass	Ret. Class =	D	G
Riprap	Mannings n =	0.040	R

Subarea-Reach	Length [ft]	Slope [ft/ft]	Qt [cfs]	I	Matl	SS [H:V] Lt	SS [H:V] Rt	B [ft]	Depth [ft]	Qcalc [cfs]	Vel. [fps]	Froude #	Tractive Shear Avg [psf]	Tractive Shear Max [psf]	FB [ft]	D+FB [ft]	Topwidth [ft]
Alt. 1 - Detention																	
Buckeye Feeder Canal:																	
99th Ave to 107th Ave	5215	0.0012	283	I	C	2	2	4	3.8	283	6.47	0.59	0.157	0.283	1.11	4.89	23.6
107th Ave to 112th Ave	3681	0.0011	960	I	C	2	2	14	4.9	960	8.29	0.66	0.222	0.335	1.49	6.36	39.4
112th Ave to 115th Ave	2196	0.0010	300	I	C	2	2	4	4.0	300	6.14	0.54	0.138	0.252	1.16	5.20	24.8
Adjacent to 115th Ave	5030	0.0017	962	I	C	2	2	10	4.9	962	9.90	0.79	0.323	0.520	1.61	6.51	36.1
115th Ave to 117th Ave	1030	0.0010	1684	I	C	2	2	12	6.9	1684	9.37	0.63	0.260	0.433	2.08	9.02	48.1
New Outfall to River	3566	0.0009	1600	I	C	2	2	12	6.9	1600	8.89	0.59	0.235	0.390	2.04	8.99	48.0
117th Ave to El Mirage Rd.	4000	0.0020	783	I	C	2	2	4	5.3	783	10.13	0.78	0.348	0.661	1.72	7.02	32.1
El Mirage Rd to Dysart Rd.	5280	0.0015	893	I	C	2	2	8	5.2	893	9.33	0.72	0.287	0.487	1.64	6.84	35.4
Dysart Rd. to Agua Fria River	4400	0.0014	914	I	C	2	2	8	5.3	914	9.15	0.70	0.274	0.467	1.66	7.01	36.0
Laterals:																	
107th Ave	1500	0.0008	725	I	C	2	2	8	5.5	725	7.01	0.53	0.159	0.273	1.56	7.02	36.1
107th Ave Lateral -(flow-by)	1000	0.0008	250	I	C	2	2	2	4.3	250	5.41	0.46	0.108	0.216	1.20	5.53	24.1
115th Ave, N. of Southern	1000	0.0013	1042	I	C	2	2	14	4.9	1042	9.01	0.72	0.262	0.395	1.53	6.40	39.6
Alt. 2 - 100-yr Conveyance																	
Buckeye Feeder Canal:																	
107th Ave to 112th Ave	2600	0.0017	1831	I	C	2	2	18	5.5	1831	11.40	0.85	0.399	0.587	1.89	7.42	47.7
Adjacent to 115th Ave	7030	0.0017	2450	I	C	2	2	18	6.4	2450	12.35	0.86	0.450	0.682	2.20	8.63	52.5
115th Ave to 117th Ave	1030	0.0009	3068	I	C	2	2	26	7.4	3068	10.17	0.66	0.287	0.415	2.25	9.65	64.6
New Outfall to Gila River	3646	0.0009	2979	I	C	2	2	26	7.3	2979	10.09	0.66	0.283	0.409	2.22	9.50	64.0
117th Ave to El Mirage Rd.	4000	0.0020	783	I	C	2	2	4	5.3	783	10.13	0.78	0.348	0.661	1.72	7.02	32.1
El Mirage Rd to Dysart Rd.	5280	0.0015	893	I	C	2	2	8	5.2	893	9.33	0.72	0.287	0.487	1.64	6.84	35.4
Dysart Rd. to Agua Fria River	4400	0.0014	914	I	C	2	2	8	5.3	914	9.15	0.70	0.274	0.467	1.66	7.01	36.0
Laterals:																	
115th Ave, N. of Southern	1000	0.0013	1042	I	C	2	2	14	4.9	1042	9.01	0.72	0.262	0.395	1.53	6.40	39.6
Alt. 3 - 10-yr Conveyance																	
Buckeye Feeder Canal:																	
107th Ave to 112th Ave	2600	0.0017	1022	I	C	2	2	10	5.1	1022	10.06	0.79	0.331	0.536	1.66	6.71	36.8
Adjacent to 115th Ave	7030	0.0017	1240	I	C	2	2	10	5.6	1240	10.58	0.79	0.357	0.589	1.82	7.38	39.5
115th Ave to El Mirage Rd	5280	0.0010	1593	I	C	2	2	12	6.8	1593	9.24	0.63	0.255	0.422	2.02	8.78	47.1
El Mirage to Dysart Rd	5280	0.0015	1593	I	C	2	2	12	6.1	1593	10.72	0.76	0.353	0.573	1.98	8.10	44.4
Laterals:																	
115th Ave, N. of Southern	1000	0.0013	495	I	C	2	2	4	4.8	495	7.68	0.62	0.207	0.386	1.42	6.18	28.7

Cost Summary - 115th Avenue Drainage Improvements

Description	Unit	Unit Price	Alt 1 - Detention Qty	Alt 1 - Detention Total	Alt 2 - 100-yr Conv. Qty	Alt 2 - 100-yr Conv. Total	Alt 3 - 10-yr Conv. Qty	Alt 3 - 10-yr Conv. Total
Land Acquisition	AC	$25,000.00	118	$2,950,000	13	$325,000	5	$125,000
Detention Basin Excavation	CY	$2.00	805171	$1,610,342	0	$0	0	$0
Channel Excavation	CY	$2.50	89660	$224,150	246089	$615,223	104866	$262,165
Remove Exist. Culverts	LS	$1.00	40000	$40,000	40000	$40,000	32000	$32,000
Culverts	LS	$1.00	728760	$728,760	1200569	$1,200,569	851419	$851,419
Channel Lining	SF	$1.40	938660	$1,314,124	1364211	$1,909,895	1157314	$1,620,240
Detention Basin outfall	LS	$717,600.00	1	$717,600	0	$0	0	$0
Floodproofing	LS	$1.00	0	$0	0	$0	624200	$624,200
SUB-TOTAL				$7,584,976		$4,090,687		$3,515,024
CONTINGENCY		15%		$1,137,746		$613,603		527253.54
TOTAL				$8,722,722		$4,704,290		$4,042,277